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TABLE OF CONTENTS

No. 1. February

	Page
Woronin (with portrait). Erwin F. Smith	1
Notes on new or little known plant diseases in North America for the year 1910. F. D. Heald	5
Flower infection with cotton boll rots. C. W. Edgerton	23
Sclerotinia panacis, the cause of a root rot of ginseng. W. Howard Rankin	28
The covering power of the precipitation membranes of Bordeaux mixture. B. F. Lutman	32
Reviews	42
Washington meeting of the American Phytopathological Society	43

No. 2. April

Inoculation experiments with fungi associated with apple leaf spot and canker. C. E. Lewis	49
Apple fruit spot and quince blotch. Charles Brooks and Caroline Black	63
Notes on some diseases of trees in our national forests. II. George Grant Hedgcock	73
Infection experiments with the powdery mildew of wheat. George M. Reed	81
The chestnut bark fungus, Diaporthe parasitica. C. L. Shear	88
Phytopathological notes	90
Washington meeting of the American Phytopathological Society	92

No. 3. June

The method of spreading of the olive knot disease. Wm. T. Horne, Wm. B. Parker and Lyman L. Daines	101
A practical and reliable apparatus for culture work at low temperatures. N. J. Giddings	106
The cause of stem-end rot of citrus fruits (Phomopsis citri n. sp). H. S. Fawcett	109
Wood rots of the hardy catalpa. Neil E. Stevens	114
A new form of pure culture chamber. E. Mead Wilcox and G. K. K. Link	120
Diaporthe, the ascogenous form of sweet potato dry rot. L. L. Harter and Ethel C. Field	121
A new internal Sterigmatocystis rot of pomegranates. S. M. McMurran	125
Phytopathological notes	127
Reviews	129

No. 4. August

Oedema on manihot. Frederick A. Wolf and Francis E. Lloyd	131
Notes on Hawaiian fungi. I. Gibellula suffulta n. sp. Alden T. Speare	135
The comparative susceptibility of cruciferous plants to Plasmodiophora brassicae. G. C. Cunningham	138
A new leaf rust of peach. S. Hori	143

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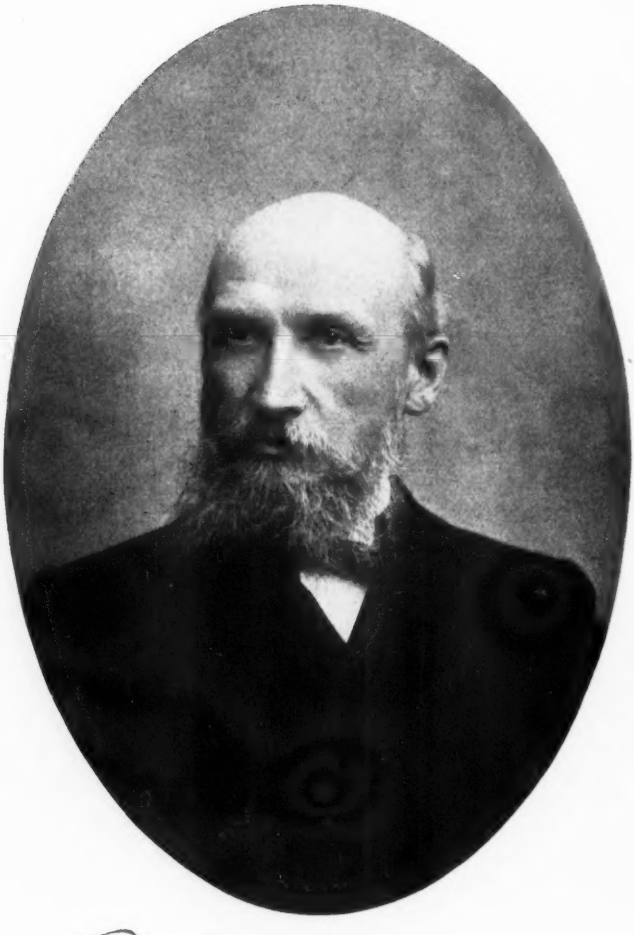
Does the potato scab organism survive passage through the digestive tract of domestic animals? W. J. MORSE 146
A college course in plant pathology. BRUCE FINK 150
A further study of some Gloeosporiums and their relation to a sweet pea disease. J. J. TAUBENHAUS 153
The trend of investigation in plant pathology. H. A. HARDING 161
Notes on three species of rusts on Andropogon. WILLIAM H. LONG 164
Field laboratory equipment. DONALD REDDICK 172
Phytopathological notes 175
Reviews 178

No. 5. OCTOBER

Apple leaf spot. CHARLES BROOKS and MARGARET DEMERITT 181
Infection experiments with Thielavia basicola on ginseng. J. ROSENBAUM 191
Culturing of parasitic fungi on the living host. I. E. MELHUS 197
The chestnut blight fungus and a related saprophyte. P. J. ANDERSON and H. W. ANDERSON 204
The chestnut blight fungus. C. L. SHEAR 211
Phytopathological notes 213

No. 6. DECEMBER

A new fungus concerned in wither tip of varieties of Citrus medica. ROY E. CLAUSEN 217
Spore germination and infection with Plasmopara viticola. C. T. GREGORY 235
Does Phytophthora infestans cause tomato blight? HOWARD S. REED 250
Apple rust controllable by spraying. E. T. BARTHOLOMEW 253
Control of apple rust by spraying. N. J. GIDDINGS and D. C. NEAL 258
Endothia virginiana. P. J. ANDERSON and H. W. ANDERSON 261
A new fungus on the apple. J. W. ROBERTS 263
Chestnut blight fuugus and its allies. G. P. CLINTON 265
Etiology of crown galls on sugar beet. ERWIN F. SMITH 270
Phytopathological notes 273
Reviews 275



Dr M. Woronin.

born at St. Petersburg
21 July
2 august 1838.

photog. 1900.

PHYTOPATHOLOGY

VOLUME II NUMBER 1

FEBRUARY, 1912

WORONIN

ERWIN F. SMITH

(WITH PORTRAIT, PLATE I)

Michael Stepanovitch Woronin was born in St. Petersburg in 1838, and died there in 1903. His father, who was very wealthy, spared no pains to give his sons a good education. The German house tutor during these early years undoubtedly had much influence in developing that liking for German life and literature which remained with him to the end as a sort of second nature. His inclination to science must have been peculiar to his constitution since none of his brothers developed it, although subject to the same early influence. However this may be, it is certain that he early developed a strong bent for scientific studies. In 1854 when 16 years old we find him leaving the gymnasium to begin his four years' course in natural history studies at the University of St. Petersburg, his dissertation on graduation being "A detailed description of granite and diorite rocks in their geognostic and geological relationships," for which he received a silver medal (1858). His first botanical teacher was the distinguished Cienkowski.

From the University of St. Petersburg Woronin passed to the University of Heidelburg and thence to Freiburg where he fell under the influence of Dr. Anton De Bary, who early recognized in him the unusual man, absorbed in the same recondite problems of nature as himself, and with whom he cemented an enduring friendship,—a friendship which lasted for 30 years and out of which grew several interesting joint contributions. His first botanical paper was an anatomical study of Calycanthus. He also made one other anatomical study on the structure of the leaves of Statice.

In 1860 Woronin studied Mediterranean algae under Thuret and Bornet at Antibes, receiving his master's degree from St. Petersburg in 1861 for his dissertation on Acetabularia and Espera. On receiving the master's degree Woronin appeared to be satisfied with honors and turned his attention to researches on the life history of the lower plants, chiefly fungi. Afterwards he received the doctor's degree, *honoris causa*, from the University of Odessa (1874). This was the

first official recognition of the value of his researches. During this period he worked partly in Germany with De Bary, partly in St. Petersburg either alone or with his colleague and friend Famintzin. His labors during this period showed him to be the original and great man he ever remained. Among these papers the following may be mentioned :

With De Bary : Contribution to our knowledge of the Chytridiaceae (German) ; Supplement to the history of the Chytridiaceae (French); Contributions to our knowledge of the Mucorinae (German).

Alone : Root swellings of black alder and garden lupins ; Whortleberry disease (*Exobasidium Vaccinii*); Sunflower disease (*Puccinia Helianthi*), and the Trientalis smut (*Sorosporium Trientalis*).

In later periods of his life Woronin gave us wonderfully illuminating papers on the club root of cabbage (Plasmodiophora); on Ceratium (with Famintzin); on *Puccinia Helianthi* ; on Botrydium ; and on various Sclerotinias, the latter being very remarkable path-breaking papers magnificently illustrated.

In 1878 he received a gold medal from the Royal Russian Society of Horticulture for his work on club root. A few years later he was named a corresponding member of the Russian Royal Academy of Sciences and received their great prize given in consideration of his important papers published between 1877 and 1882.

But these honors were of small importance, as Nawaschin points out, in comparison with the recognition and honor bestowed upon him by his scientific colleagues the world over. As early as 1880 his name was known in every quarter of the globe as a very original and distinguished investigator, possessed not only of unusual powers of observation, but endowed with a genius for painstaking, so that his papers remain models of lucid presentation and convincing illustration, (he usually made his own illustrations and published them at his own expense). This recognition on the part of his fellow workers undoubtedly brought him more true pleasure than all the official preferment, but he was not in any sense puffed up thereby. Always he was the kind friend and helpful true gentleman—to paraphrase St. Paul, thinking not more highly of himself than he ought. Indeed humility was one of his shining virtues, hence the host of friends and the loving esteem of all his fellow workers, even those born to foreign tongues and living in distant lands. "Far from the madding crowd," in peace and quiet, he pursued "the even tenor of his way," searching in lonely quiet those deep mysteries of cryptogamic life which had ever for him an all absorbing fascination.

At this time he refused a call to Odessa, but in 1869 to 1870 he gave lectures on fungi as privat docent at the University of St. Petersburg. From 1873 to 1875 he served as Reader of Mycology and Anatomy of the Plant Cell in the higher medical school for women at St. Petersburg. Most of his life, however, he was an independent worker.

Woronin was not much given to speculation, preferring to stick close to the solid ground of well ascertained fact and evolving hypotheses only so far as he could try them out for the discovery of new facts by experimental methods. Excursions into abstract and subjective speculation were not to his taste.

He was religiously inclined but not disposed to discuss or expose the sacred things dear to him.

Throughout his life he was free from the pecuniary vexations that perplex most of us, and was able to devote his best energies to his beloved science. He was a member of various learned societies and for 30 years secretary of the botanical section of the Society of Naturalists of St. Petersburg. He also assisted pecuniarily in the establishment of the botanical institute of the University, in the founding of a biological station at Bologoje, and in the publication of the botanical records of the first 25 years of the Society of Naturalists.

Woronin was even greater as a man than as a botanist. He had few if any enemies and a very wide circle of friends drawn to him by his lovable personality. His disinterestedness, it is said, often passed over into what might almost be termed self denial.

The accompanying half tone is from a photograph sent to me by Woronin in 1902. The substance of this article is drawn from two sources, the German obituary by Nawaschin (Berichte d. d. bot. Ges., 21 Jahrg., Generalversammlungs Heft), and the Russian obituary by Famintzin (Tr. Imp. Soc. Nat., St. Petersburg, Vol. 34). The latter gives a botanical bibliography of 64 titles. Of these papers the major number were fundamental studies, still unnegligible. A mycelial body appearing at the time of the formation of the ascogenous fruit body was named for him Woronin's hypha. There is also an algal genus Woronia, and a fungous genus Woroninella.

In conclusion, I will cite a few paragraphs from the two authors mentioned, showing the character of the man:

"On February 23 at 4 P. M. was buried M. S. Woronin, ordinary academic of botany and one of the most zealous members of the Society of Naturalists of St. Petersburg. He died at 10:30 P. M. February 20, 1903, after ten days of grave suffering. We buried one of the best of Russian men. Besides his unlimited devotion to the science which brought to him a world-wide popularity in his chosen specialty, Michael Stepanovitch was irresistably attractive to every one who had the privilege of acquaintance with his sympathetic person. His character, to

which is to be attributed the cordial relation of the people about him, may be expressed in the following words: To him were entirely unknown these three traits common to most of us—vanity, egotism and human malice; instead of these he was more able than many not only to forgive but also to forget offence. If one chanced to see him indignant even his anger was directed upon the evil deed not upon the person who committed it." (Famintzin.)

"Whoever is familiar with the rooms over-abundantly supplied with apparatus and instruments, which have come into use with modern microbiology and mycology, would be not a little astonished, if he had entered Woronin's workroom. In the city as well as in the country he worked in his bedroom. There stood a little work-table covered with a towel, on which, under a bell-jar were arranged painfully clean "the old Hartnack" (Hartnack & Prazmowski, middle-sized model), with needles and razor, and on the window-ledge some plates with cultures, for the most part under ordinary tea-glasses. But it was really a pleasure to see how splendidly fungi or algae thrived in these simple cultures. Woronin's dexterity in handling living plants was truly wonderful." (Nawaschin.)

"A renowned investigator who worked indefatigably on botanical problems for almost half a century, who was early recognized by the most eminent foreign scholars and scientific societies as a man of importance in the scientific world, Woronin, throughout the length and breadth of his own country was admired, loved and revered still more as a man, as a most winning personality endowed with the most noble attributes." (Nawaschin.)

NOTES ON NEW OR LITTLE-KNOWN PLANT DISEASES IN NORTH AMERICA FOR THE YEAR 1910[1]

F. D. HEALD

I. Diseases of Tree Fruits
II. Diseases of Small Fruits
III. Diseases of Citrus and Other Tropical Fruits
IV. Diseases of Garden Vegetables
V. Diseases of Cereals and Field Crops
VI. Diseases of Forage Crops and Grasses
VII. Diseases of Tropical Plants Used in Commercial Industries
VIII. Diseases of Trees and Shrubs
IX. Diseases of Ornamental Plants
Literature Cited

I. DISEASES OF TREE FRUITS

Coryneum foliicolum Fckl. as an apple fungus is discussed by Lewis (23). The organism has been previously reported as associated with the spotting of apple leaves, but Lewis shows that it causes *cankers* upon the twigs and branches and a slight decay of the ripe fruit, although he agrees with Hartley that it is not an active parasite upon the leaves. The same author (23) has studied another fungus, *Phoma Mali* Schulz. and Sacc., and concludes that it causes cankers of apple twigs and branches, while it also produces a rapid and complete decay of ripe fruit and attacks green fruit to some extent. Both of the fungi mentioned are more actively parasitic than *Coniothyrium pirina*, and acting as wound parasites, attack the tree in a way somewhat similar to *Sphaeropsis malorum*. A new species, *Endomyces Mali* has been described from decaying apples in Maine (24). The author discusses the cultural characters, structure and morphology of the organism but decides that it is only a minor factor in bringing about decay of ripe apples. A Fusarium decay of apples has been reported from Maine (27). Three forms have been isolated and have been found to cause decay of both green and ripe fruit. One is reported as being very similar to *F. putrefaciens* Osterwalde which has been mentioned as the cause of an apple decay in Europe.

[1] This was prepared at the request of the Editors in accordance with the announcement, 1 : 70. It was the author's expectation that it would appear in the last issue of the previous volume. The space limitations prevented this, however. It is the hope of the editors, with the cooperation of Dr. Heald to make this an annual publication, the notes for 1911, to be included if practicable in a late number of the current year. Authors are requested to continue to send papers for such review to Dr. F. D. Heald, University of Texas, Austin. L. R. J.

A new apricot disease has appeared in the Santa Clara Valley, California (28) which attacks young fruits, causing a destructive rot. The fungus which causes the trouble is believed to be *Botrytis cinerea*. Losses of from one-fourth to one-half of the crop are reported.

In 1907 Rolfs published a preliminary report on the die-back, a new and destructive disease of the peach and recently (42) the same writer has given us a detailed consideration of the trouble under the title, "Winterkilling of twigs, cankers, and sun-scald of peach trees." By means of cultures and inoculations the author shows that *Valsa leucostoma* (Pers.) Fr., which produces a pycnidial stage described as *Cytospora cincta*, is responsible for the killing back of peach twigs, limbs and branches in such a way as to resemble winter-killing, also causes cankers upon the twigs and limbs and areas designated as "sun-scald" upon the larger limbs and trunk. The fungus also causes a similar trouble on the apricot, cultivated cherry and wild cherry, and plum trees.

The mistletoe (*Phoradendron flavescens* Nutt.) has been reported by O'Gara (29) as causing serious injury to the apricot plum (*Prunus Simonii*) in California.

The importance of the honey agaric, *Armillaria mellea* Vahl. as the cause of root disease of tree fruits is brought to our attention by Lawrence (22). This fungus which affects many different hosts is reported to be abundant in the Puget Sound country on apples, cherries and plums.

II. DISEASES OF SMALL FRUITS

Recent texts on plant diseases in America make no mention of the honey agaric as a parasite upon blackberries or raspberries. The recent bulletin by Lawrence (22) reports *Armillaria mellea* Vahl. as very abundant in sections of the Puget Sound country upon these hosts. Some doubt is expressed in regard to this fungus being the main cause of loss in plantings apparently affected by it. Another fungus (species not given), to which considerable importance is attached, is also present.

Cook has studied the "double blossom" disease of the dewberry, a trouble which was first recognized in 1885. Although the disease has been observed since that time in various localities little attention has been paid to the cause. Cook has determined by means of cultures and inoculations that the disease is caused by *Fusarium Rubi* Wint., which was first described as *Fusisporium Rubi* by Winter. (6). The fungus causes a witches' broom effect and many of the flowers on affected portions are variously deformed. The work referred to clearly

establishes the etiology of the disease and adds one more to the rapidly increasing list of Fusarium diseases.

III. DISEASES OF CITRUS AND OTHER TROPICAL FRUITS

A "blight" of the banana has been known for many years, but it has only recently become sufficiently prevalent and destructive to cause special concern. The disease in Central America has been discussed by McKenney (26) and the general conclusion reached that it is caused by a "vegetable parasite" which makes its entrance into the plant through the rhizomes or roots. The importance of the disease is indicated by the fact that in Panama alone 15,000–20,000 acres of banana plantations have been abandoned as a result of the ravages of the disease, while some adjacent regions have suffered even heavier losses. The control of the disease is difficult, no good method being known. It is encouraging to note however that the author claims to have discovered a variety that is immune.

What is probably the same disease has been studied by Smith (50) from material received from Cuba. The trouble or at least a similar one is known to exist in Jamaica, Dutch Guiana, and Trinidad. Bacteria and fungi are reported to be present in the vessels of diseased stems and leaves. Smith has isolated a fungus from the diseased Cuban material which he has designated provisionally as *Fusarium Cubense*. Successful inoculations with this fungus were reported but it was not definitely determined that it could cause the typical blight. The Fusarium in question may be only an accompaniment of the diseased condition but it has been demonstrated that it can grow for considerable distances through the vessels and cause a purple or blackish stain of the vascular bundles. The author leaves the question still open by suggesting that possibly there are two banana diseases now confused under the name of "blight," one due to bacteria and the other to a fungus.

Brief mention may be made of a number of orange diseases which have been reported from Mexico. Gandara (12) mentions the occurrence of *Gloeosporium Psidii* Del. on the fruit where it produces brown sunken spots 1-3 mm. in diameter. This fungus was first described by Delacroix in 1903 as occurring on the lemon guava, and also later by Sheldon who discovered an ascigerous stage.

The above writer also records the presence of the omnivorous parasite, *Dematophora necatrix* Hartig as a serious pest of orange trees (12). Two parasitic phanerogams, a dodder, *Cuscuta americana* and a mistletoe, *Loranthus calyculatus*, are also noted as affecting orange

trees. The epiphytic phanerogam, probably incorrectly referred to *Tillandsia recurvata*, is also mentioned as a parasite.

Fawcett has studied a new trouble of the orange, the stem-end rot, in Florida and attributes the trouble to a fungus (11) which grows in the interior of the diseased fruits. Sweet oranges, grape fruits, sour oranges, and tangerines are affected. The fungus appears to be distinct from the brown rot fungus, *Pythiacystis citrophthora* which is troublesome in California, and the results of a more detailed study are promised for a later time.

The silver scurf or "thrip marks" of the orange has also been studied by Fawcett (11) and the conclusion has been reached that a fungus "which produces Alternaria spores in cultures, if not the immediate cause, is at least one of the main factors in producing the disease." This work suggests that the fungus present may be *Coniothecium scabrum* described by McAlpine from Australia but the identity of the two has not been definitely established.

A new species of imperfect fungus, *Stemphylium Citri* Patterson has been described as occurring in Arizona in connection with a trouble of oranges known as "end rot." (35). It was demonstrated by cultures that the fungus is constantly associated with the "end rot," and inoculations of pure cultures into healthy fruits develop satisfactorily. Whether the fungus is the cause of the "end rot" is left undecided.

Brief mention may be made of the study of pineapple rot caused by *Thielaviopsis paradoxa* (35). The fungus causes a rotting of pineapples imported into this country, but recent text books do not mention the trouble. The article noted makes no mention of the occurrence of the trouble in American grown fruit. It is demonstrated by experiments that "formaldehyde gas even in small quantities exerts a retarding action on the initial growth of *Thielaviopsis paradoxa*, while with certain quantities it is fatal in its fungicidal effect." The general conclusion is reached that formaldehyde gas may be used as an efficient means of controlling the pineapple rot.

IV. DISEASES OF GARDEN VEGETABLES

A disease of the cabbage new to the United States has been reported by Manns (25) from Ohio. What is probably the same trouble has been reported as occurring in Holland under the name of "Fallsucht," in France under the name, "pourriture des pieds de chou" or foot rot of cabbage, and in Australia as the "black leg or foot rot" of cabbage and cauliflower. Manns describes the disease under the name of

"black leg or phoma wilt" and agrees with Quanjer that it is due to *Phoma oleracea* Sacc., which was formerly considered a saprophyte. The serious nature of the disease in the countries mentioned and its appearance in the cabbage growing sections of Ohio indicate that it is likely to become a troublesome pest in many parts of America.

The first occurence of *Puccinia Porri* (Sow.) Winter in America has been noted by Clinton (4a) in Conneticut on chives as the cause of considerable injury. Both uredinia and telia were collected.

A new hop mildew has been described by Davis (8) from Wisconsin and assigned to *Pseudoperonospora celtidis* (Waite) Wilson as var. *Humuli*. No mention is made as to the extent of injury caused by the fungus.

The first occurrence in this country of the fungus, *Mycogone perniciosa* Magnus, which has been for many years a serious menace to mushroom growing in England and on the continent has been reported from mushroom beds in Pennsylvania (34). It is to be hoped that the disease will not become generally established in this country.

In the summer of 1909, Giddings[1] first called attention to a troublesome rot of muskmelons in Vermont. What was apparently the same trouble was reported in 1904 from Connecticut,[2] although no especial study was made of it. A detailed account of the disease has been published and the cause attributed to a new and undescribed bacterium for which the name *Bacillus melonis* is proposed (13). The trouble first made its appearance in a field of Montreal muskmelons in the fall of 1907. Field work and cultures in the laboratory showed a constant association of a single bacterial organism with the rotting melons and inoculation experiments have given conclusive evidence of its pathogenesis. A detailed study of the cultural characters of the organism is presented and as a result it is described as a new species since comparison with other bacteria causing rot of vegetables indicates that it is distinct. A brief discussion of remedial measures is included.

A serious disease of the potato due to *Chrysophlyctis endobiotica* which has been unusually severe in England and on the continent during recent years has been imported into this country. According to Güssow it has made its appearance in Newfoundland (14). Since the disease is particularly severe a note of warning has been sounded in order to guard against the introduction of the trouble into Canada and the United States (30). The disease in question has been designated as the "potato wart" or "potato canker," since peculiar outgrowths or excrescences somewhat resembling crown-gall tumors are produced upon the tubers. The causal organism belongs to the

[1] Giddings, N. J. Science, N. S. **29**: 911. 1909.

[2] Clinton, G. P. Report of the Botanist. Rpt. Conn. Agr. Exp. Sta. 1904, p. 320.

Chytridineae and has been described under various names. A recent detailed study of the cytology and life history of the fungus has been made by Percival [1] and as a result he has returned it to the genus Synchytrium.

In 1905 Clinton mentions the occurrence of *Heterosporium variabile* Cke. as a leaf mold of spinach on specimens obtained in the New Haven market in January. The parasitic nature of the fungus was not established and the place of growth of the molded plants was not known. According to a report by Clinton (4a) this fungus was apparently described by Cooke in 1889 as *Cladosporium subnodosum*. Recently Reed (40, 41) has studied a disease of spinach in Virginia due to this fungus. The morphology of the fungus was studied in detail and its relation to the disease in question determined by cultures, inoculations and field observations. The conclusion is reached that *Heterosporium variabile* is a weak parasite which is only able to attack the leaves of spinach which have been weakened by various other factors. Leaves injured by cold weather are especially susceptible while plants under optimum conditions are practically immune. Plants suffering from malnutrition (see p. 11 of this article) afford a condition which favors the entrance of the fungus, and depredations by insects give an additional factor which accentuates the trouble, while the attacks of *Peronospora effusa* Grev. appear to be a forerunner of Heterosporium infections.

Another has been added to the growing list of bacterial diseases of plants by the discovery of a new disease of tomatoes in Michigan by Smith. (48). The trouble was first studied in the summer of 1909, and has been assigned to a new species, *Bacterium michiganense*. The disease is very clearly distinct from the well known bacterial blight of the potato and other species of the Solanaceae. The trouble advances more slowly than that due to *Bacterium solanacearum* and the author is inclined to the opinion that the two bacterial diseases have been confused in varions portions of the United States. That the new disease is one which is likely to prove of considerable economic importance may be inferred from the serious losses resulting in the Michigan fields where the disease was known to be present.

The first certain demonstration of the existence of oospores of *Phytophthora infestans* is especially noteworthy. The existence of oospores of this fungus has long been a disputed point, but Clinton (4a) after long and careful work has succeeded in obtaining them in artificial cultures on oat juice agar.

Sulphur injury to potato tubers has been reported as occurring in

[1] Percival, J. Centralbl. Bakt. u. Par., II Abt., **25** : 440-470. 1911.

California fields (31) where sulphur was used in disinfecting soils for the scab fungus or where the seed potatoes were treated with sulphur. Dark sunken spots 5-30 mm. in diameter on the surface of the tubers were characteristic of the trouble and the writers have shown by experiments that potatoes subjected to sulphur fumes will develop similar depressed and discolored spots.

Malnutrition diseases of cabbage, spinach, and other vegetables have been reported by Harter[1] (15) from the trucking sections of the Atlantic coast. Affected plants make a poor growth and produce small stubby roots with few or no lateral roots. Leaves become chlorotic between veins and around the margin, while the chlorophyll is conserved along midrib and veins. Diseased specimens are richer in starch than normal ones, due supposedly to production of an insufficient quantity of diastase of translocation. The author points out the relation of acid soils to the development of the disease and shows that the trouble can be corrected by the addition of calcium carbonate.

V. DISEASES OF CEREALS AND FIELD CROPS

A disease of barley known as "yellow leaf disease" due to *Helminthosporium gramineum* has been noted from time to time in America, and is of frequent occurrence in Europe. A new trouble due to a related species, *Helminthosporium sativum*, which is described as new, is reported from Iowa and adjacent territory. It is designated as the "late barley disease" in contrast to the "early barley disease," a name sometimes applied to the yellow leaf disease (32). The fungus grows upon leaves, stems, spikelets, and sometimes upon the grains, causing a reduction of yield and layering and rotting of the straw. The parasitic character of the fungus was determined by inoculations for which pure cultures were used. Cross inoculations in corn led to the conclusion that the fungus is distinct from any of the species of Helminthosporium described as affecting this host. It is claimed that the fungus is carried over from one season to another by infected seed.

Brief mention may be made of the report by Shaw (46) on the "curly top" disease of sugar beets, in which it is claimed that the leaf hopper, *Eutettix tenella* Baker, is the primary cause of the trouble.

A disease of sugar cane, the red rot, which has been very destructive in various foreign countries, has made its appearance in the United States being reported from Georgia, Florida and Louisiana (10). Edgerton who has studied the trouble reports it in serious form from the localities mentioned. The disease is due to *Colletotrichum falcatum*

[1] Also reported earlier by the same writer. Harter, L. L. Bul. Virginia Truck Exp. Sta. 1. 1909.

Went., a species which is morphologically quite similar to *Colletotrichum lineola* Cda., a form which is common on sorghum and Johnson grass. In this connection it may be noted that Stevens and Hall[1] report an anthracnose of sorghum from North Carolina due to *Colletotrichum falcatum* Went. It seems somewhat doubtful as to the presence of this fungus in the locality mentioned, since more or less confusion prevails concerning the two species mentioned. The writer has recently received information that the *Colletotrichum lineola* Cda. of American mycologists and pathologists is identical with *Colletotrichum Andropogonis* Zimm. The matter of relationship of the various Colletotrichum species attacking the Gramineae is a topic which requires further investigation.

Patterson has described a new species of fungus, *Stemphylium Tritici*, associated with the floret sterility of wheat in the southwest. It is reported as occurring in the living leaves and ovaries (33) of wheat in Texas and Oklahoma.

Floret sterility of wheat is not uncommon in the southwest and this trouble has been made the subject of special study by Johnson (21). The non-development of kernels in otherwise normal spikelets has been attributed to various causes, as insects, fungi, or physiological conditions. Culture and inoculation experiments were carried on at San Antonio, Texas, as a result of which the conclusion was reached that the new species of fungus mentioned above together with other associated forms of imperfect fungi are important factors in producing floret sterility. The trouble is also increased in severity by rust infections. Sterility was increased 3 per cent. by inoculations with *Cladosporium gramineum*, 9 per cent. by inocculations with *Stemphylium Tritici* and 21 per cent by inoculations with uredospores of *Puccinia graminis*. Climatic factors also play a part as is indicated by an increase in sterility of over 12 per cent. by shading.

VI. DISEASES OF FORAGE CROPS AND GRASSES

Sackett has published a detailed account of a bacterial disease of alfalfa in Colorado (43) which was first briefly mentioned in 1906 by Paddock, and by the former again in 1909. The trouble is one of considerable severity since losses of as high as 80% of the first cutting are reported. The disease is attributed to a new species of bacterium, *Pseudomonas Medicaginis*. What appears to be a similar disease has also been reported from Utah, New Mexico, Nebraska, and Kansas. The primary infections are in the stem but leaves may be directly attacked, and the organism may even invade the tap-root. Affected plants may be stunted and dwarfed and portions killed or the entire

[1] Stevens, F. L. and Hall, J. G. Diseases of economic plants, p. 364. 1910.

plant may succumb. The author discusses the symptomology and effects of the disease, cause and method of infection, prevention and treatment, and presents a comprehensive account of the morphology, cultural characters, physical and biochemical features, and pathogenicity of the causal organism. The bacterium has not proved pathogenic for any other species of legumes upon which it has been tested.

A rust of *Andropogon Hallii* Hack. collected in Kansas and Nebraska, and erroneously referred to *Puccinia Cesatii* Schrot. has been described as a new species, *Puccinia Ceanothi* (Ellis & Kellerm.) Arthur (2). The aecial stage of this rust was first described in 1884 as *Aecidium Ceanothi* Ellis & Kellerm., on *Ceanothus ovatus* Desf. and Arthur has established the relation to the Andropogon rust by successful cultures upon *Ceanothus americanus*.

Brief mention may be made of two new species of grass rusts: *Puccinia Deschampsiae* Arthur on *Deschampsia caespitosa* (L.) Beauv. from Long's Peak, Colorado and *Uromyces Glyceriae* Arthur on *Glyceria septentrionalis* Hitch. from Wisconsin and Illinois and on *Glyceria acutiflora* Torr. from Rhode Island. The latter species has been mistaken for *Uromyces Poae* Rabenh. (1).

Three new species of Claviceps have been described by Stevens and Hall (54). *Claviceps Paspali* S. & H. and *Claviceps Rolfsii* S. & H. on *Paspalum laeve* and *Paspalum dilatatum*. Both are associated with what has heretofore been designated as *Sclerotium Paspali* Schw. *Claviceps Tripsaci* S. & H. is described as occurring in heads of *Tripsacum dactyloides* L. Ascophores of the three species described were grown from sclerotia collected in the field and planted on moist earth in glass capsules kept at room temperature.

VII. DISEASES OF TROPICAL PLANTS USED IN COMMERCIAL INDUSTRIES

An account of a new disease of a bamboo (*Phyllostachys* sp.) has been published from the Bureau of Plant Industry (35). The trouble produces a general appearance of the host which resembles a witches' broom and is assigned to *Loculistroma Bambusae* described as a new genus and species. The Chinese bamboo fungus is related to the stromatic Hypocreaceae according to the authors. The material upon which the study was based was obtained from near Hankow, China, and no definite mention of the occurrence of the disease in American plantings is included.

A new disease affecting cocoa in the West Indies has been described by Bancroft (3). The fungus which attacks the pods is referred to *Colletotrichum Cradwickii* nov. sp.

The guayule or Mexican rubber plant (*Parthenium argentatum*

Gray) is the host for a rust which grows also upon other species of Parthenium. The rust which was first assigned to *Uredo Parthenii* Speg. in 1899, is now named *Puccinia Parthenii* (Speg.) Arth. since recent collections in Mexico have yielded the teleutospore stage. The rust affects the oldest leaves at the base of the season's growth. (1).

The rubber tree (*Castilla elastica*) has been attacked by a serious disease in Southern Mexico. The trouble which is designated as a trunk rot has been investigated by Crawford (7). While the author considers the disease to be of fungous origin it is not assigned to any definite species.

A disease of one of the sedges (*Cyperus tegetiformis* Roxb.) used in the matting industry has been imported into this country according to Patterson and co-workers (35). The trouble is caused by a fungus, *Kawakamia Cyperi* (M. & I.) Miyabe, recently described in Japan, which appears to be allied to Phytophthora. The disease has been prevalent in Japan and made its appearance in the Texas plantation, at Pierce, on stock obtained from that country.

VIII. DISEASES OF TREES AND SHRUBS

The bladder senna (*Colutea arborescens* L.) is attacked by a rust, *Uromyces Coluteae*, which is described as a new species (1). This rust was first collected in this country at Manhattan, Kansas, in 1887, but has been erroneously referred to *Uromyces Genistae-tinctoriae* Wint.

A disease of the incense cedar, (*Libocedrus decurrens*,) known as "pin rot" or "peckiness" has been known since 1899. The fungus which causes the trouble is described by Hedgcock (20) as a new species, *Polyporus amarus* Hedg. In this connection it may be noted that the disease was assigned to *Polyporus Libocedrus* by Von Schrenk[1]. Type specimens and description being lacking it cannot be determined whether his specimens were identical with *P. amarus* or not.

The whitening of the mountain cedar (*Sabina sabinoides* (H.B.K.) Small) has been studied in Texas (18) and attributed to a new species assigned to a new monotypic genus, *Cyanospora albicedrae* H. & W. This trouble, which is probably co-extensive with the range of the mountain cedar, produces conspicuous white patches upon the bark of limbs and branches, and attacked branches are frequently very much corroded and killed. The definite parasitic relation of the fungus was not established since all attempts at cultures failed.

In 1908 Kern[2] described a new species of rust, *Gymnosporangium exiguum*, on the mountain cedar from Texas, but at that time its aecial

[1] Science N. S. **16**: 138. 1902.

[2] Bull. Torr. Bot. Club, **35**: 508. 1908.

host was not known. Arthur (2) reports successful inoculations of this species upon *Crataegus Pringlei* from material collected at Austin, by Heald and Wolf, and has assigned specimens collected at Boerne, Tex. on an undetermined Crataegus to this species.

The statement that the Austin material was on *Juniperus virginiana* L. is probably an error.

A new species of rust, *Gymnosporangium trachysorum* Kern has been described from various southern stations (2). The telia have been collected from South Carolina and Mississippi on *Juniperus virginiana* L., and the aecia on various Crataegus species in Alabama, Louisiana, and North Carolina.

Another new species *Gymnosporangium cornicularis* Kern is reported (2) as producing telia on *Juniperus horizontalis* Moench. in Michigan. The aecia are produced upon various species of Amelanchier and collections are reported from Michigan, New York, Vermont, Massachusetts and West Virginia.

The red cedar, (*Juniperus Virginiana* L.) is attacked by *Fomes annosus* in Delaware. According to Hartley (17) this fungus is responsible for the death of cedars and also of *Pinus Taeda* L. It has been previously recorded on pines in New England and is known to be a dangerous root parasite of coniferous trees in Europe.

Marssonia Castagnei (Desm. & Mont.) Sacc. has been prevalent upon certain species of Populus and recently Edgerton (9) has reported the first occurrence in this country of *Trochila Populorum* Desm., a discomycete, which is supposed to be the perfect stage of the poplar fungus. He adds some circumstantial evidence of the relationship but as yet definite proof is lacking.

Arthur (1) has described a new species of rust, *Peridermium fructigenum* which produces pycnia and aecia on the cones of the hemlock, *Tsuga canadensis* (L.) Carr. The species is based on collections made at a single locality in Connecticut.

Peridermium Peckii Thuem. on the hemlock has been shown by Clinton (4) to be the aecial stage of *Pucciniastrum Myrtelli* (Shum.) Arth.

According to Peck (36) an undetermined hickory (*Carya* sp.) is attacked by a new species which he names *Phyllosticta subtilis*. The abundance of the fungus and its effect upon the host are not noted.

The same author (36) also described a new form, *Septoria Acerismacrophylli* on living leaves of the maple (*Acer macrophyllum* Pursh.) and another new species belonging to the same genus, *Septoria samarae* is reported as occurring on the wing of the fruit of the box elder (*Acer Negundo* L.) and the dwarf mountain maple (*Acer glabrum* Torr.)

An interesting parasite upon a parasite has been described by Wolf (60) as *Macrophoma Phoradendri*. This parasite causes the death of leaves and subsequent defoliation of the mistletoe (*Phoradendron flavescens* Pursh.), but the injury is only temporary as the mistletoe renews its activity with the seasonal growth of the host and recovers from the attack.

Polystictus hirsutus Fr. has been reported by Pollock (38) as a wound parasite of the mountain ash. According to this author the fungus is able to spread gradually from the dead heart of the tree into the cambium and finally kill the tree.

A bacterial disease of the mulberry which was first studied in Italy and later in France has been prevalent in this country at least since 1905, but the work of Smith (49) and assistants has shown that the disease was probably incorrectly assigned to a bacterium producing yellow colonies. The causal organism of the disease in this country, as shown by cultures and inoculations is a form producing only white colonies. Smith has retained the original name *Bacterium Mori* B. & L. and furnishes an emended description.

A new species, *Glœosporium divergens* Peck. has been described (36) from living leaves of the white oak, (*Quercus alba.*) It is not reported as causing any injury.

Two new diseases of the willow oak (*Quercus phellos*) are mentioned by Von Schrenk (56) due to two polyporoid fungi but the brief abstract of the paper available does not include the names of the fungi causing the trouble.

The first case of a trunk disease of the osage orange has been studied by Von Schrenk (57), and attributed to a fungus which enters the heart wood of living trees. The available abstract makes no mention of the nature of the invading organism, and we are left to surmise that it is a polypore. This case is especially noteworthy since the osage orange has been practically immune to wood-destroying fungi.

The osage orange (*Toxylon pomiferum* Raf.) has been mentioned as the host of a new species, *Septoria angustissima* Peck, from Mississippi. No mention was made of injurious effects. (36).

One of the principal causes of damping-off of pine seedlings is a Fusarium which has been known to be prevalent in this country during the past few years. The trouble was first reported in America by Jones[1] and has recently been studied by two different workers (16, 39). Pollock records work which indicates a probable relation between the Fusarium and a species of Nectria found upon the ground. It re-

[1]Jones, L. R. Ann. Rep. Vt. Agr. Exp. Sta., **20**: 342-347. 1906-1907.

mains however for further work to furnish definite proof of the relationship.

An account of the importation into the United States of *Peridermium strobi*, the cause of the blister rust of the pine was given by Spaulding [1] in 1909, but the presence of the disease received much additional attention during the following year. (37, 52, 53).

The importance of this trouble is evidenced by the fact that the American Phytopathological Society passed resolutions viewing with alarm the recent introduction, and pledging its support to secure legislation for the control of its importation.

The fungus upon the alternate host, Ribes, has been collected in America at a number of points and recognized as *Cronartium ribicola*, since 1906, but the disease has never been widely distributed until the large importations of 1909 which were sent by one German firm to many different parts of the United States and Canada, scattering broadcast trees infected with the aecial stage. The serious character of the disease upon the white pine in Europe, calls for a rigid inspection of all pine seedlings imported into this country.

Two additional species of pines, *P. maritima* and *P. austriaca* are reported by Clinton (4a) as new American hosts for *Peridermium pyriforme* Pk., which produces its uredinia and telia on the sweet fern.

Peck has described *Phyllosticta paupercula* n. sp. as occurring on the living leaves of the service berry (*Amelanchier alnifolia* Nutt.) at Stockton, Kansas. The abundance of the fungus and the effect on the host are not indicated (36).

A new disease of the snowberry (*Symphoricarpos racemosus*) has been described by Stewart (55) from New York. Leaves, berries and young canes are affected and the disease which is of fungous origin is doubtfully attributed to a Glœosporium, which is however not assigned to a definite species.

A new species of rust, *Uredo Spirostachydis* Arthur, has been described as occurring on the succulent stems of *Spirostachys occidentalis* S. Wats. in the vicinity of Yuma, Arizona (1).

Scouler's willow (*Salix Scouleriana* Barr.) has been reported as the host of a new species, *Cylindrosporium conservans* Peck. The fungus causes a discoloration of the leaves except adjacent to the affected spots where the chlorophyll is conserved. (36).

The importance of the mistletoe problem in the southwest is evidenced by the fact that the trees and shrubs of that section are attacked by ten species and varieties belonging to the genera, Razoumofskya and

[1] Spaulding, P. Circular Bureau of Plant Ind. 38: 1-4. 1909. Science, N. S. 30: 200-201. 1910.

Phoradendron. Blumer (4) records thirty-one host species some of which have not been previously mentioned. According to this author Razoumofskya is confined to the pines, while the Phoradendron species occur on Juniperus species and various deciduous trees. Hedgcock however records the occurrence of *R. Douglasii* (Eng.) Kunze on *Pseudotsuga taxifolia* (Poir) Britt.

An additional report of general character by Hedgcock (19) on the diseases of trees in our National Forests should be mentioned. The occurrence and distribution of the following wound parasites has been studied: *Polyporus dryophilus* Berk., *P. obtusus* Berk., *P. sulphureus* Fr., *P. Schweintzii* Fr., *Fomes ignarius* Gill., *F. applanatus* (Pers.) Gill. *F. Laricis* (Jacq.) Murr., *Trametes Pini* (Brot.) Fr. and *Echinodontium tinctorium* E. & E. Unfortunately the new hosts claimed for several of these species are not recorded in the brief obstract published. Presumably the detailed report will appear later.

IX. DISEASES OF ORNAMENTAL PLANTS

Two different writers have reported the occurrence of a blighting and rotting of the flowers of chrysanthemums grown under greenhouse conditions, but no mention is made by either writer of an earlier report due to the fungus in question. Patterson (35) attributes the disease to *Botrytis cinerea* Pers. and Spaulding (51) describes a somewhat similar trouble more in detail referring the fungus to *Botrytis vulgaris*. Neither of the authors determined the parasitism of the fungus by cultures and inoculations.

In this connection it may be noted that a "petal-rot" of the chrysanthemum was observed by the writer[1] in Nebraska in 1905 and somewhat doubtfully attributed to a Botrytis species. The reason for expressing doubt was the absence of definite proof of the parasitism since inoculations had not been carried out.

Coreopsis (*Coreopsis tinctoria*) has been reported as a new host for *Erysiphe cichoracearum* De. C. from New York. The mildew was not mentioned as being especially destructive. (55).

What appears to be the first occurence in this country of *Puccinia Cyani* (Schl.) Pass. on the cornflower, *Centaurea Cyanus* is reported by Clinton from Connecticut. Both telia and uredinia were collected.

The stem blight of cosmos (*Cosmos bipinnatus*) is not a new disease, but it has been studied more in detail in New York (55) and as a result the causal fungus which was first referred to the genus Phlyctaena by Halsted has been described as a new species, *Phomopsis Stewartii* Peck[2]. The constant association of the fungus with the diseased

[1] Heald, F. D. Ann. Rep. Nebr. Agr. Exp. Sta., **19**: 57. 1906.

[2] Peck, C. H. N. Y. State Museum Bul. **139**: 27. 1910.

condition of the cosmos has been substantiated by ten year's of study, but artificial inoculations with either pure cultures or bits of diseased tissue have not been attended with success.

The cyclamen (*Cyclamen* sp.) is affected by a leaf trouble, the cause of which has recently been assigned to a new variety of the ascogenous fungus, *Glomerella rufomaculans* (Berk.) Sp. & von Schr. The var. *cyclaminis* Patt. produces a Colletotrichum form for the imperfect or conidial stage, but perithecia are produced in abundance upon the diseased spots on the leaves (35).

The Christmas fern (*Dryopteris acrostichoides*) has been reported as a new host for *Exoascus filicinus* (Rostr.) Sacc. which has hitherto been known only from Sweden. The specimens on the new host were collected at Chapel Hill, N. C. (5).

Pathological literature contains but few references to diseases of gladioli, but recently Wallace (58) has studied the bulb rots of this host. The reports covering the subject are of a popular character. Four troubles are recognized: A soft rot due, probably, to bacteria; scab, probably caused by a fungus; hard rot and dry rot from both of which fungi have been isolated giving successful inoculations. None of the organisms are named and presumably we may expect a detailed report at a later date.

According to Stewart (55) the nasturtium (*Tropaeolum majus*) should be added to the already long list of hosts for *Albugo candidus* (P.) Kze. The trouble was noted only on a few leaves of dwarf nasturtiums.

A Botrytis disease of paeonies first described in Europe in 1897 has made its appearance in this country (35). The trouble which has proved destructive in Canada and eastern United States is due to *Botrytis Paeoniae*. The fungus invades the stems and produces numerous sclerotia 1-1½ cm. in length, but no perfect stage is known.

An undetermined species of palm from Mexico has been recorded as the host for a new species of nectriaceous fungus, *Macbridella olivacea* Seaver. The fungus produces a Verticillium form as its conidial stage. The fungus was grown in cultures and successful inoculations were made on leaves of Chamaedorea species (45).

Another has been added to the increasing list of diseases caused by *Fusarium* with the study of a destructive disease of the pansy, (*Viola tricolor* L.). The disease in question is attributed by Wolf (59) to *Fusarium Violae* sp. nov. The fungus invades the stem at about ground level and causes a rotting of stem and roots ending in the death of the affected plants.

Peck (36) has described a new species of Cercospora on phlox (*Phlox* sp.) from New York. The trouble was first reported by Stewart (55). Very numerous brown spots upon the leaves characterize the disease, but apparently little injury was produced.

A Botrytis disease of "poinsettias" (*Euphorbia pulcherrima*) has been noted by Spaulding (51). The disease was prevalent in the same greenhouses in which chrysanthemums affected with a similar trouble had grown two years previous. The fungus attacked the green leaves but the bright colored bracts were not affected.

A wilt of the variegated vinca (*Vinca major*) has been studied by Stewart (55) and attributed to an unassigned species of Phoma. The fungus invades the stem at about ground level, and causes the death of the affected shoots.

Brief mention may be made of the note (47) confirming the relation between *Uromyces Andropogonis* Tracy and *Aecidium pedatum* Schw. Violet leaves inoculated with the Uromyces spores from *Andropogon virginicus* L. gave aecia after 15 days. The definite connection being established, attention was called to the fact that following the rules of nomenclature the name of the rust becomes *Uromyces pedatus* (Schw.) Sheldon.

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FLOWER INFECTION WITH COTTON BOLL ROTS

C. W. EDGERTON

(WITH PLATE II.)

During the past few years, it has been shown by a number of observers that some fungi have the power to enter the flower of the host plant and to grow down into the seed or fruit. While some of the smuts furnish the best examples of this phenomenon, there are other plant parasites which show the same thing in varying degree. The recent studies of Barre[1] with the cotton anthracnose have shown that this fungus can enter the cotton boll by a primary infection in the flower. From a careful study of his papers, it would seem that Barre believes that the fungus grows on the old flower parts, through them, and into the boll tissue, preferably on the line of dehiscence between the carpels.

During the past four years, a study of the different cotton boll rots has been made at the Louisiana station and the question of flower infection has been made a prominent part of the study. It has been proven that two of the disease organisms, *Glomerella gossypii* and *Bacterium malvacearum*, can cause an infection of the bolls following inoculations in the flowers. With several other organisms which frequently cause boll rots, flower inoculations have given no results.

Infection of cotton bolls following flower inoculation takes place in either of two ways as follows:

First. The organism may grow saprophytically upon the dead flower parts and finally grow through and into the boll. This method of infection is really no different from merely inoculating the surface of the young boll with the disease germs. The dead parts of the flower merely retain the fungus or bacteria until suitable conditions render infection possible. This method of infection cannot be considered as true flower infection.

Second. The organism causing the disease may grow down through the pistil into the boll. The boll may be infected on the inside alone, or there may be a rot of all parts of the boll beginning at the tip and working towards the base. It would seem that this method should be considered as true flower infection.

The cotton bacterium, *Bacterium malvacearum*, infects bolls through the flowers by the first method, while the cotton anthracnose, *Glomerella gossypii*, follows both methods.

[1] Barre, H. W. Cotton anthracnose investigation. Annual Report South Carolina Exp. Sta. **22**: 89-118. 1909.

Spots on the bolls produced by the cotton bacteria are very common in Louisiana cotton fields. They are most abundant on bolls half grown or under, but are not uncommon on larger bolls up to the time the boll tissue begins to harden. They are slightly darker in color than the surrounding tissue and have a watersoaked appearance (Fig. 1). As the tissue dies and dries out, these spots become sunken and brownish in color. They also generally become infected with the cotton anthracnose or some other rot so that their identity is soon lost (Fig. 2).

To test the possibility of flower infection with this organism, in the season of 1911, a number of flowers were inoculated with pure cultures. The bacteria were washed off in pure water until the water was deeply clouded. About a half a cubic centimeter of this bacterial suspension was then dropped into a flower in the late afternoon. Of course the flower would close up during the following night and the bacteria would be held in a more or less moist environment. This gave the bacteria a chance to grow and develop and as the flower rotted or dried up to come in contact with the developing boll beneath.

On a considerable percent of the young bolls developing from flowers inoculated in this manner, the watery spots typical of this organism developed. These spots developed at various places on the bolls but were more abundant on the upper portion, frequently about five to ten millimeters from the tip. Sometimes as many as fifteen or twenty spots developed on a single boll. The spots on the bolls in Fig. 1 developed from flower inoculations. The checks, which were treated with water alone, in place of the suspension of bacteria, remained perfectly healthy for two weeks or more and then only a small per cent developed spots. The results of the inoculations are as follows:

Date of inoculation	June 27	June 29	Total
No. of inoculations	36	38	47
Inoculations with spots in 12–14 days	43%	47%	45%
Inoculations with spots in 20–22 days	51%	47%	49%
Inoculations with spots in 29–31 days	68%	73%	71%
No. of checks	30	37	67
Checks with spots in 12–14 days	0%	0%	0%
Checks with spots in 20–22 days	3%	7%	6%
Checks with spots in 29–31 days	34%	21%	27%

An examination of the table shows that, during the first two weeks, 45% of the bolls developing from inoculated flowers were affected with the disease, while none of the check bolls were affected. After the first two weeks, there was an outbreak of the disease throughout the field and the natural infection increased the percent of the disease on both the inoculated and the check bolls in about the same proportion.

It is evident that the bolls which became infected from the bacteria in the flowers showed the disease in two weeks time; otherwise the increase of the disease on the inoculated bolls would have been greater than on the checks. Another experiment tried in July when the disease was very abundant did not give any reliable data since the percent of infection was very high with both the inoculated and check bolls.

With the cotton anthracnose, flower inoculations will produce infection in either of the two methods described above. The spores may germinate and grow in the dead flower parts and later cause an infection at any point on the young boll; or they may grow down through the pistil into the young boll. When the latter method of infection occurs, the appearance of the rot varies considerably with the surrounding moisture conditions. During wet weather, the fungus will not only rot the inside of the boll but will gradually rot the outside also, beginning at the tip and working towards the base (Fig. 3). Frequently the rot in the center of the boll does not spread much faster than down the capsular tissue. A boll rotting in this way almost always splits at the apex, the splitting beginning shortly after infection. Badly infected bolls are sometimes split to the base (Fig. 6). Under other conditions, the fungus may grow down into the inside of the boll and not affect the capsular tissue (Fig. 4). To one not familiar with the disease, a boll affected in this manner would not be detected from an outside examination. However a very small dead place at the apex, with a very slight splitting of the carpels on the lines of dehiscence at the same point, will generally show the presence of the disease. The boll in Fig. 4 shows the path of the fungus well. The small area of blackened tissue at the tip shows the place of entrance of the mycelium. The whole inside of the boll is black and badly decayed while the outside of the boll looks perfectly normal with the exception of the very small split at the apex.

In the Louisiana experiments, there has been no predominance of spots on the lines of dehiscence between the carpels, differing in this respect from the results obtained by Barre in South Carolina. Tip infection, or true flower infection as it is described above, has been the most common. Bolls affected at other places had the spots more frequently between the lines of dehiscence than on them (Fig. 5). Most of the inoculation experiments in Louisiana were conducted in the seasons of 1910 and 1911, though some preliminary experiments in the summer of 1908 showed that cotton bolls could be inoculated through the flowers. The inoculations were made in a similar manner to those with the cotton bacteria described above. In the 1910 experiments, the bolls were examined after from 15-22 days and the total

percent of diseased bolls and the percent diseased at the tip were ascertained. The results of the inoculations of that year are given in the following table:

Date of inoculation	July 13	July 15	July 18	July 21	Total
No. of inoculations	28	38	20	36	122
Inoculations affected	57%	39%	40%	50%	45%
Inoculations affected at the tip	7%	14%	20%	28%	17%
No. of checks	26	24	5	29	84
Checks affected	4%	4%	0%	0%	2%

During July, when these experiments were run, there was considerable rain and many of the young bolls were shed. These bolls were not considered in the above table. Of the 122 bolls developing from the inoculated flowers, 45% became infected; while only 2% of the checks developed the disease. Of the inoculated bolls 17%, and of the checks none, developed the disease at the tip. Unfortunately, the location of the spots on the rest of the diseased bolls was not noted in the 1910 experiments.

The 1911 experiments were carried out in a similar way to the 1910 except that the bolls were watched more carefully and the point of infection noted in each case. The total infection after different periods is shown in the following table:

Date of inoculation	June 24	June 26	June 27	Total
No. of inoculations	46	74	65	185
Inoculations affected in 15-17 days	24%	19%		21%
Inoculations affected in 23-25 days	24%	28%	29%	28%
Inoculations affected in 31-34 days	35%	34%	38%	36%
No. of checks	19	18	29	66
Checks affected in 23-25 days	0%	0%	0%	0%
Checks affected in 31-34 days	0%	6%	7%	5%

An examination of the table shows that there was the greatest development of the disease during the first two weeks following the inoculation. During the third and fourth weeks the disease developed more slowly, but still during the fourth week, there was a greater development of the disease on the inoculated bolls than on the checks showing that some of the infection must have been due to the inoculation and not to the natural infection which was increasing in the field.

Notes were taken on each boll in regard to the location of the point of infection, whether at the tip of the boll, on the line of dehiscence between the carpels, or on the capsular tissue between the lines of dehiscence. The percentage of infection on the different places 23-25 days after the inoculation, is shown in the table below. There was no increase in tip infection after this period.

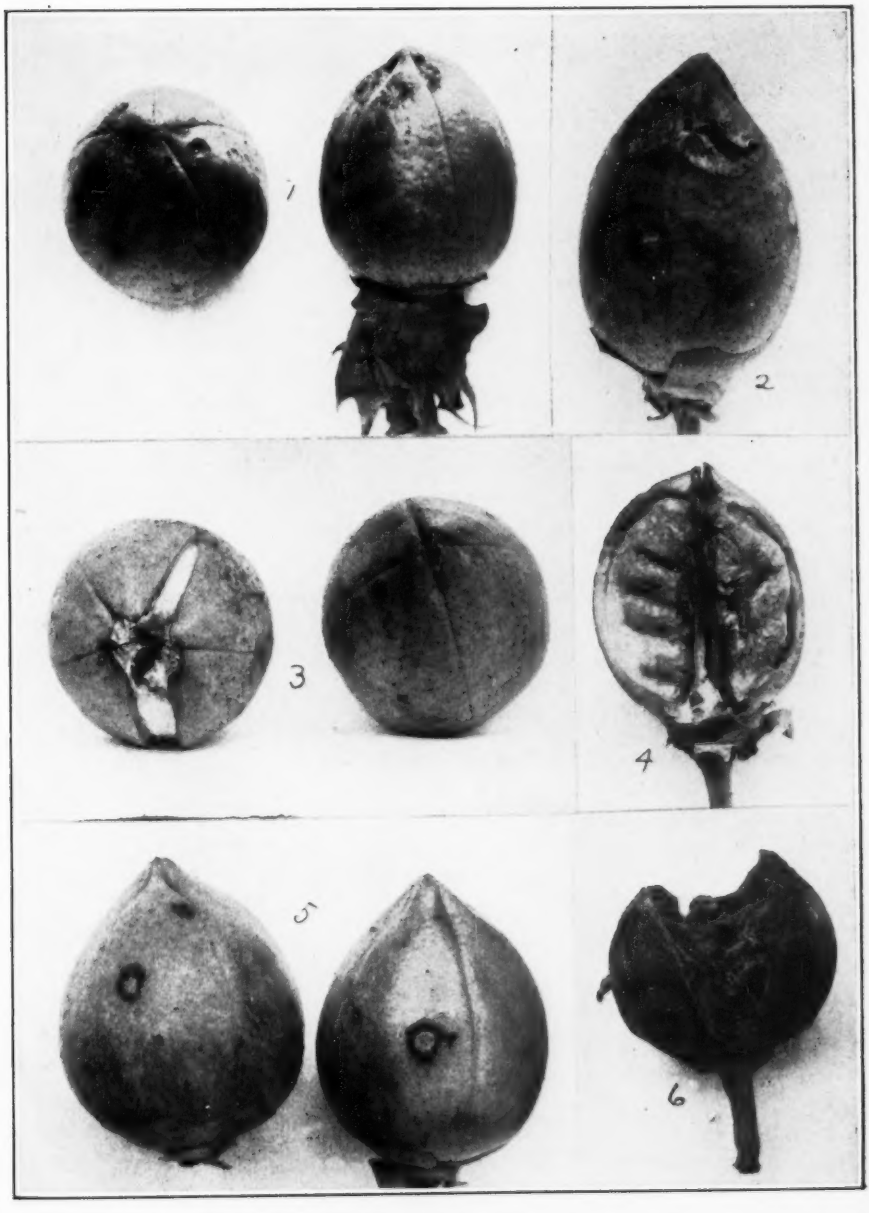


PLATE II. **Cotton Boll Rots**

Date of inoculation	June 24	June 26	June 27	Total
No. of inoculations	46	74	65	185
Total infection	24%	28%	29%	28%
Infected at tip	13%	23%	15%	18%
Infected on lines of dehiscence between carpels	2%	1%	5%	3%
Infected between lines of dehiscence	9%	4%	9%	7%

In this table, it is seen that more than half of the diseased bolls were first attacked at the tip, while the percentage of infection on the lines of dehiscence was small. When the bolls are small, they are very readily infected with the anthracnose, though as far as has been observed in Louisiana, no part of the boll is more susceptible than another. The predominance of the rot at the tip seems to be due to the fact that the dead pistil presents a condition similar to a wound and infection takes place much more readily in a wound than on the uninjured epidermis.

While the inoculations described above, show that bolls can become infected through the flowers, they do not show that this is the usual method of infection. The placing of a half a centimeter of a heavy suspension of spores in a flower is certainly an abnormal condition. Under natural conditions, where the flowers only remain open for a day, the number of spores that would actually find an entrance into a flower would be small, and furthermore unless there was a rain to partially fill the flower with water and supply moisture, the conditions for germination would not be the best. Of course, a spore that actually came in contact with the nectar of the flower would germinate and possibly cause infection, but it is readily seen that the chances for infection are much less than where a large number of spores are placed in water in the flower. This is also borne out by observation in the field. While it is not uncommon to find young bolls affected at the tip, the actual percentage compared to the total percentage of the disease is very small.

LOUISIANA AGRICULTURAL
EXPERIMENT STATION

PLATE II. **Cotton Boll Rots.**

FIG. 1. Spots on cotton bolls produced by *Bacterium malvacearum* following flower inoculation.

FIG. 2. Anthracnose on cotton boll following a bacterial spot.

FIG 3. Cotton bolls affected at the tip with the anthracnose following flower inoculation.

FIG. 4. Tip infection with cotton anthracnose following flower inoculation, showing the path of the fungus to the center of the boll.

FIG. 5. Cotton anthracnose on the sides of bolls following flower inoculation.

FIG. 6. Boll badly diseased with the anthracnose following flower inoculation.

All figures natural size.

SCLEROTINIA PANACIS SP. NOV. THE CAUSE OF A ROOT ROT OF GINSENG

W. HOWARD RANKIN

(WITH PLATE III AND TEXT FIGURE)

While investigating the diseases of ginseng in the summer of 1909, the writer[1] became interested in the sclerotial disease of the ginseng roots commonly known to the growers as black rot. While not very common this disease is known to occur in widely separated localities in the ginseng growing regions. It was first reported by VanHook[2], from New York. He shows a photograph of diseased roots and describes the general characters of the disease, but apparently made no attempt to work out the life history and taxonomy of the causal fungus. The distribution of this disease as shown by specimens in the collection of the Department of Plant Pathology of Cornell University is as follows: Cassville, N. Y., 1906 and 1909; Apulia, N. Y., 1907, 1909, 1910; Castorland, N. Y., 1909; Rosehill, N. Y., 1910; Apple Creek, Ohio, 1910; Portland, Mich., 1910.

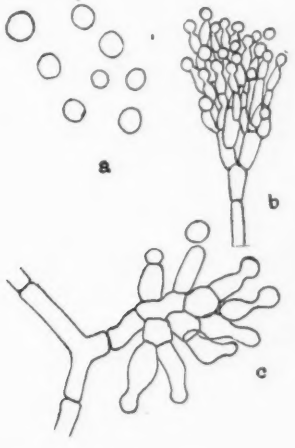
On a visit to a garden at Apulia, N. Y., badly affected with this disease, it was learned by inquiry that sound and apparently healthy roots had been set in the beds the fall before (1908). In the spring vacant spots in the beds gave evidence of some trouble. Examination showed that the roots were coal black in color (Plate III, Fig. 2) instead of the normal cream white of the healthy root. The fact that the whole change had occurred between the months of October and May was puzzling. The buds were perfectly black and showed no sign of having started, pointing to the fact that the development of the disease had taken place entirely during the winter months. This peculiarity of the disease had also been noted by VanHook (1904: 182). Taking specimens to the laboratory direct transfer cultures were made and the plates set aside in the culture room at the ordinary room temperature. No growth followed. Recalling the fact that the disease developed in the beds during the winter several other direct transfer cultures were made and the plates placed in an ice box at a temperature of 4° C. Abundant mycelial growth was obtained in a few days and the typical sclerotia were soon formed (Plate III, Fig. 4), the entire growth becoming black. The mycelium was rhizoctonia-like, very abundant and profusely branched.

[1] Rankin, W. H. Black rot of ginseng roots. Special Crops. 8: 208-210. 1909.

[2] VanHook, J. M. Diseases of ginseng, N. Y. (Cornell) Agr. Exp. Sta. Bul. 219: 181-182. 1904.

The actively growing cultures were removed from the ice box after about a month and divided into two groups of a dozen each. One set was kept at room temperature (approximately 70° F.) all fall and winter while the second set was kept in a place where the temperature at night was about as low as out of doors. In those cultures exposed to low temperature at night the sclerotia all produced profuse mycelial growth in November while in no case did any growth occur in the first set, which had been kept at room temperature.

Conidia of the micro-conidia type were produced in pure cultures on bean pods and potato agar. These conidia were globose, small 3—5.5μ, (Fig. a), and borne on irregularly, verticillately branching conidiophores, (Figs. b & c).



In the late spring of the next year (June, 1910) the writer visited the same garden and examined the *same diseased spots* that had furnished the black rotted roots the previous year. Apothecia of the Sclerotinia type were found developing from buried black roots that had been overlooked in digging out the diseased roots on our previous visit. This would indicate that the apothecial stage did not develop until the second spring after infection. The vegetative activity of the sclerotia during the autumn following their formation and the fact that the diseased roots remain firm and are only blackened part way through during the first season (Plate III, Fig. 3), while those which bore the apothecia were collapsed and hollow would also add weight to this opinion. Two black rotted roots were dug which bore several apothecia attached and growing from the sclerotia (Plate III, Fig. 1). Careful study of the perfect stage of the fungus showed that it differed in many respects from those species of Sclerotinia al-

ready described. It was submitted to Dr. E. J. Durand who pronounced it different from any of the Sclerotinias with which he was acquainted and probably a new species.

Primary infection of the root seems to occur at no regular place. Some infections were found which had started at the crowns and others in smaller roots. The outer cortical tissue of the root is attacked first and completely disorganized, being replaced by a tangled mass of black mycelium. At this stage the root is tough and pliable; within it is still the natural color, but instead of being compact and brittle it is soft and watery. There is no offensive odor as is the case with the soft rot, but the characteristic taste is lost and it is somewhat bitter. Infected roots lying in the ground the second winter become black throughout. It is probable that the spread of the parasite in the garden is due largely to the abundance of the Rhizoctonia-like mycelium which may be readily detected in the crevices of the soil surrounding diseased roots by the minute drops of water which are exuded. The sclerotia thus furnish in the autumn a new growth which serves to spread the disease the second season. That there is no spread of the disease during the growing season has been well established by field observations.

As to control measures for this disease no practical experiments have been made. However, in the culture work the fungus was found to grow equally well on either alkaline or acid media. This would seem to indicate that the fungus would grow equally well in an acid or alkaline soil. Whether or not the acidity or alkalinity would effect its pathogenicity can only be ascertained by experiment. During the winter of 1909-1910 the black rot disease spread so extensiveley in the garden where the type material was gathered that the grower despaired of raising ginseng against such odds and went out of the business. Eradication of affected roots and soil sterilization with formaldehyde or steam ought to prove an effective means of control.

Sclerotinia Panacis Sp. Nov.

Apothecia scattered or gregarious and sometimes caespitose; sclerotia large .3–1 cm. in diameter, irregularly depressed-globose, solitary or aggregated, black; discocarp fleshy, sub-coriacious, closed or globose at first, then expanding, flat, rotate with a distinct depression in or near the center from which radiate folds in the hymenium, mostly distorted or irregularly lobed, 1.5–2.5 cm. in diameter, madder brown (Oberthur & Danthenay)[1]; stipe smooth, variable in length, tortuous, 2-3mm. thick, tapering downward.

[1] Oberthur & Danthenay, Repertoire de couleurs Vol. 2.

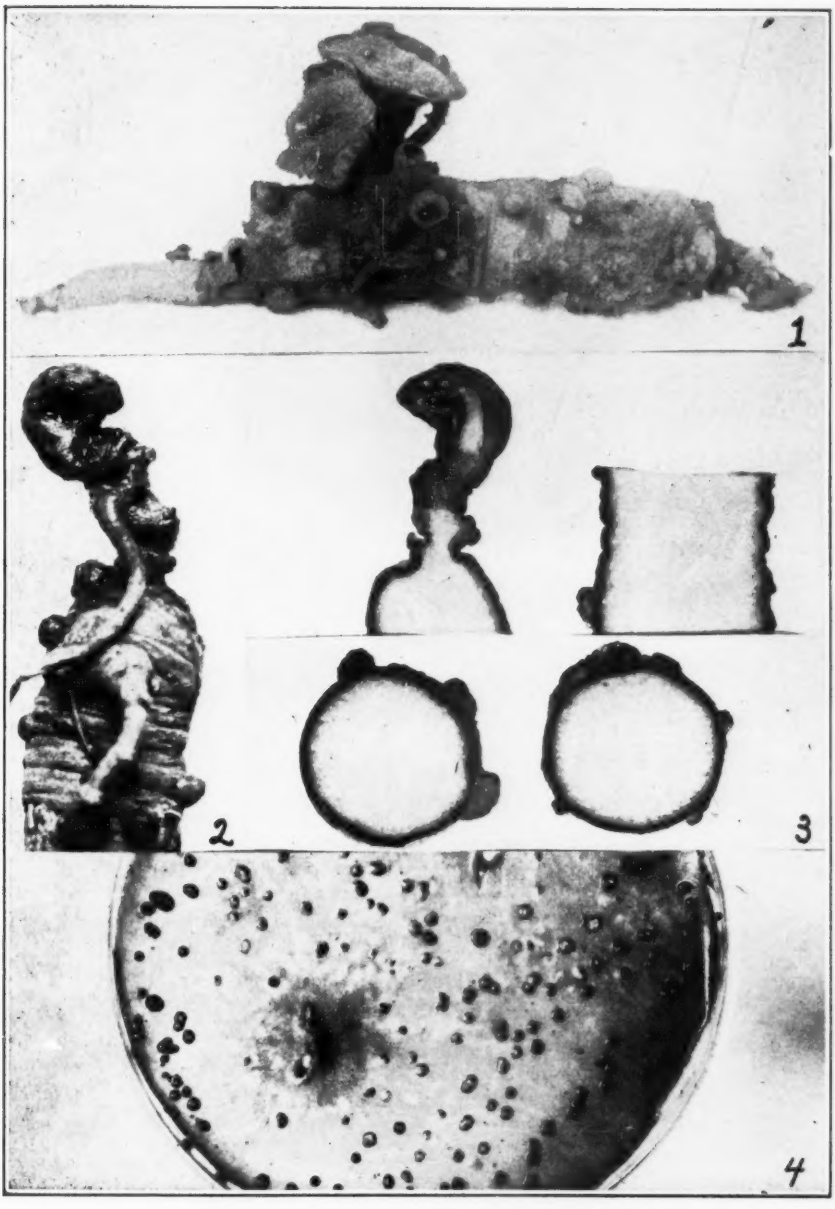


PLATE III.—**Sclerotinia Panacis Rankin**

FIG. 1. Apothecia from ginseng root.

FIG. 2. Large black sclerotia.

FIG. 3. Cross and longitudinal sections of ginseng root showing blackening effect of the fungus.

FIG. 4. Sclerotia developed in plate culture.

Asci narrowly cylindrical, with rounded apices, 125-137.5x6.4-6.5μ, eight-spored. Spores obliquely uniseriate, hyaline, biguttulate, continuous, smooth, elliptical, 11.7-16x4.8-7.5μ. Paraphyses scarce, slightly thickened at apex. Conidia in potato agar cultures, globose, small, 3–5.5μ, borne on verticillately branching conidiophores. Mycelium Rhizoctonia-like, abundant in culture, at first hyaline and later black. Sclerotia formed abundantly in culture.

Apotheciis gregariis vel solitariis, nonnunquam caespitosis; sclerotiis, magnis. 0.3–1 cm. diam., irregulariter depresso globosis, solitariis vel aggregatis, nigris; discocarpis carnosis, sub coriaceis, initio clausis vel globosis, dein expandentibus, planis, rotatis clare depressis in vel prope centrum, unde sinus in hymenio radiatim extendunt, plerumque contortis vel irregulariter lobulatis 1.5–2.5 cm. diam, rubro-brunneis (Oberthur & Danthenay)[1]; stipite levi, tortuso, vario in longitudine, 2-3 mm. diam., obconico.

Ascis constricto-cylindraceis, apice rotundatis, 125–137.5 x 6.4–6.5, octosporis. Sporidiis oblique monosticis, hyalinis 11.7–16 x 4. 8–7.5. Paraphysibus sparsis, apice paulo tumescentibus; conidiis globosis 3–5.5μ, in conidiophoris verticillatis. Mycelio Rhizoctonia simile, initio hyalino, dein nigro.

Hab. in rhizomatibus *Panax quinquefolium* in terra immersis prope Apulia, N. Y., Amer. bor.[2]

Found attached to sclerotia of "black-rotted" tubers of cultivated ginseng, *Panax quinquefolium* L., in garden of Mr. Frank Timmerman, Laborador Lake (near Apulia Station) N. Y., June 30, 1910. Type specimen, Pathological Herbarium, Department of Plant Pathology, New York State College of Agriculture at Cornell University. No. 5230.

This specimen resembles *S. smilicinae* Durand[3] and *S. tuberosa* (Hedw.) Fckl. very closely but differs in the size of the sclerotia and in the host plant. No cross inoculations have been attempted.

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[1] Oberthur & Danthenay, Repertoire de couleurs Vol. 2.

[2] Latin version by Mr. P. J. Anderson.

[3] Durand, Elias J. Studies in North American Discomycetes II. Some new or noteworthy species from central and western New York. Bull. of Torrey Bot. Club 29: 462-463. 1902.

THE COVERING POWER OF THE PRECIPITATION MEMBRANES OF BORDEAUX MIXTURE

B. F. LUTMAN

(WITH SIX TEXT FIGURES)

The varied and complex chemical changes which occur when an aqueous copper sulphate solution and milk of lime are mixed will not be discussed in detail in this paper. Chester (1) gives the simplest possible reaction that could occur between milk of lime and a copper sulphate solution :

$$CuSO_4, 5H_2O + CaO, H_2O = Cu(OH)_2 + CaSO_4 + 5H_2O.$$

The copper hydroxide is the blue precipitate while the $CaSO_4$ and $Ca(OH)_2$ remain, partly at least, in solution.

This reaction has been widely copied in station publications and by Fairchild (2) and Lodeman (3), although by these latter authors with doubts as to whether the equation really expresses all the chemical changes that occur.

Swingle (6), while giving no reactions, states that the product of the combination of copper sulphate solution and milk of lime "consists essentially of a nearly or quite saturated aqueous solution of calcium sulphate and calcium hydrate, containing in suspension a considerable quantity of calcium sulphate and copper hydroxide, and also a varying amount of calcium hydroxide."

The blue precipitate is the copper hydroxide.

According to Pickering (5) who has most recently investigated the chemical reactions involved, the compounds vary with the proportions of the constituents used. Among those that may be formed from a copper sulphate solution and either lime-water or milk of lime are :

A. $4CuO, SO_3$ (or $10CuO, 2.5\ SO_3$)
B. $5CuO, SO_3$ (or $10\ CuO, 2SO_3$)
C. $10CuO, SO_3$
D. $10CuO, SO_3, CaO$
E. $CuO, 2CaO$ (or $10CuO, 20CaO$), existence doubtful.
F. $CuO, 3CaO$ (or $10CuO, 30CaO$)

The peculiar physical structure of the copper compound which is precipitated is the characteristic which gives to Bordeaux mixture a great share of its value ; and it is on the physical properties of this precipitate, whether simply copper hydroxide, as assumed by Chester and the early investigators, or the series of complex compounds found by Pickering, that the present work has been done.

The sky blue flakes produced when a copper sulphate solution is mixed with milk of lime are commonly spoken of as a "precipitate." Swingle (6) was apparently the first to call attention to the fact that these flakes appear, under the microscope, to be really precipitation membranes similar to that produced when a bit of copper sulphate is dropped into a solution of iron ferrocyanide, and commonly called "Traube's cells." The simplest way in which this may be illustrated in the case of Bordeaux mixture is by carefully pipetting a drop of milk of lime into a weak solution of copper sulphate. Wherever the lime water and copper sulphate solution come into contact, a blue layer is formed, and a sack of this blue layer encloses a drop of milk of lime which it separates from the copper sulphate solution surrounding it. This membrane is a very delicate one at first and easily broken, but if allowed to remain undisturbed for a few hours will become sufficiently thick that the dish containing it may be carried around without breaking the vesicle. The stronger solutions of copper sulphate and lime-water seem to produce at once a thicker membrane, *i.e.* one more difficult to rupture, which, after standing for some hours, becomes so firm that the copper sulphate solution may be pipetted off and the vesicle containing the lime water still retain its form. The addition of sugar to the milk of lime, before dropping it into the copper sulphate solution so weakens the film and increases the osmotic power of the lime water that the drop will take up water from the copper sulphate solution and flow out in all directions. This weakening of the precipitation membranes may be one of the principal values of the addition of sugar to Bordeaux mixture; the membrane being thinner and more pliable will flow out easily and apply itself closely to any irregular surface.

With the ordinary strengths of the two constituents, the membranes formed will neither change their shape nor grow. The osmotic power of the solutions on the two sides of the membrane seems to be so nearly balanced that, after the drop falls into the copper sulphate solution, it does not increase or diminish in size. Swingle (6) observed them growing; he says (p. 13) "the membrane breaks at some point probably because of pressure from within, and as the solution pours out of the break a new membrane is at once formed, inclosing the liquid a second time." Such growths, according to my observations, are not found unless the membrane is forcibly broken from without, as by a needle. If this be done the liquid on the interior pours out until a new membrane, sufficiently strong to retain it, is formed anew. The best way in which to observe this is to drop a little milk of lime in a

copper sulphate solution, and, after the precipitation membrane is formed, to break it at one side.

Inside the precipitation membrane formed by adding clear lime-water to the copper sulphate solution (as in making Pickering's Bordeaux) there is present only the lime-water. Inside those produced in the ordinary Bordeaux mixtures, however, there is present not only the lime water but also solid particles of lime which always keep the water in the interior saturated with calcium hydroxide. A break in the film means that the copper sulphate solution, in the latter case, always comes in contact with saturated lime-water, otherwise no more membrane would be produced from milk of lime than from clear lime water.

The importance of breaking the films by thorough stirring is obvious; the films will not rupture of their own accord and every new surface means an increase in the covering power of the mixture and a saving of materials. It would seem that by repeated and prolonged stirring the amount of precipitation membranes might be indefinitely increased. This has been found to be true up to a certain limit, this limit being determined by the quantity of copper sulphate and lime present; in other words, a definite quantity of copper sulphate combines with a definite quantity of milk of lime to form a definite quantity of films providing the two constituents be of a low dilution and the mixing be thorough.

Pickering (5, p. 39–47) has made some interesting studies on the volume occupied by the precipitate obtained from the same weight of copper sulphate to which has been added different amounts of lime water. He finds that the maximum amount of precipitate is formed when the proportion of Ca O to Cu SO_4 is as 9 to 1, a .2% copper sulphate solution being used. He says correctly that "the final volume of the precipitate in ordinary Bordeaux mixture made with milk of lime is always less than that made with lime water." This implies of course that the same amount of lime is used in the two cases. The difference in volume he assumes to be due to the chemical composition of the compounds produced: the degree of hydration varying. The presence of lime in the precipitation membranes weighting them down in the case of the Bordeaux made from the milk of lime is however probably the principal cause of the difference.

In the present work the object has been to attempt to measure as nearly as possible, the actual area of the precipitation membrane produced by copper sulphate solution and lime-water, or milk of lime. Six mixtures were tried: Pickering's Bordeaux and five made from milk of lime and copper sulphate solution. Pickering's Bordeaux con-

sists of the precipitate formed by a weak copper sulphate solution and a saturated solution of lime water. Water at 20° C., about the temperature at which the experiments were performed, contains, according to Maben (4), 0.126 parts of CaO in 100 parts of water. This would mean that in fifty gallons there would be dissolved about 225 grams or nearly half a pound of lime. Four strengths of Bordeaux mixture made from milk of lime were employed, the same weight of copper sulphate and lime being used in each case. These were what are commonly called the 2½–2½–50, 5–5–50, 10–10–50, and 20–20–50 Bordeaux mixtures. It will be noted that the amount of lime and copper sulphate is doubled in the successive mixtures. The sixth mixture was 5 pounds of lime with enough of a weak copper sulphate solution to bring it to neutrality.

About 100 cc. of the Bordeaux mixtures was made from the desired proportions of lime and copper sulphate. As good a quality of lime as could be obtained was carefully slaked, and the ordinary commercial copper sulphate, such as is used in spraying, was employed, but neither of the constituents was free from impurities. The two mixtures were poured together, thoroughly stirred, and then further agitated by pouring from one beaker to another. The bacteriological method of dilutions was used to get the membranes isolated sufficiently so that a definite proportion of those in a cubic centimeter could be measured. One cubic centimeter of the Bordeaux mixture was diluted with from two to four hundred cubic centimeters of water, depending on the strength of the mixture ; 1-200 being sufficient dilutions for all bordeaux mixtures up to and including the 5-5-50, the others requiring the 1-400. While the liquid was being agitated, one-half cubic

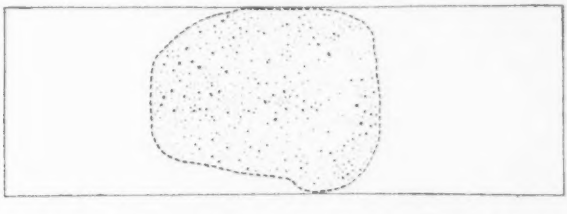

FIG. 1. Slide showing dried ½cc. of Bordeaux mixture with membranes.

centimeter of this dilution was carefully pipetted out on an ordinary glass slide and allowed to dry there. One half cubic centimeter was used as it was found that this would form a drop of about the right size on the slide (Fig. 1). The slide, after drying, usually over night, was washed in a 1-2% acetic acid solution of potassium ferro-cyanide. This removed the lime and gave the copper in the films a reddish ap-

pearance which made the outlines much easier to follow under the microscope. The dilution had to be sufficient so that when the films were dried to the slide they would over-lap as little as possible.

The slide was then placed under the microscope and by means of the "netz" micrometer eyepiece and the camera lucida five fields were drawn from various parts of the spot. In order to avoid any personal bias in the matter the mechanical stage was used and the fields were drawn that happened to come under the micrometer eyepiece (Fig. 2). At least ten slides were examined in this way and these slides had dilutions from at least three different lots of the same strength of Bor-

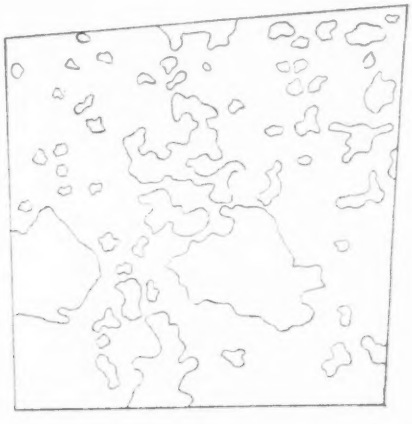

FIG. 2. Area from slide as drawn through the netz micrometer eye-piece with the camera lucida. The distortion is due to the projection. x about 50.

deaux mixture. Thus 5-5-50 Bordeaux mixture was made at least three different times; dilutions from it being made each time and dried on slides. Five fields from each of the ten slides, making fifty fields in all were drawn of this strength of the mixture. In this way it was hoped to eliminate as far as possible the errors due to the varying qualities of the materials, to pipetting, and to uneven drying of the drops on the slide.

The area drawn and the area of the larger membranes was measured by means of the planimeter while that of the smaller ones was estimated. In this way the proportion of the total area drawn to that covered by the film could be estimated. The area drawn usually contained about 90 square centimeters while the area of film in them was, we may say, 22.5 square centimeters. This meant that one fourth of the area of the spot on the slide was covered by Bordeaux membranes. The area of this spot could be accurately determined by the planime-

ter. It averaged usually about 3 square centimeters. This meant that the films in $\frac{1}{200}$ or $\frac{1}{400}$ cubic centimeter of the bordeaux mixture covered 0.75 of a square centimeter or that the total covering power of a cubic centimeter of a given mixture was 300 or 600 square centimeters. It must be remembered that in drying the two sides of the membrane dry down against the slide and only count as one area.

The method is a fairly accurate one for comparative results but it must be pointed out that the film membranes are never smooth but are folded and wrinkled to an extent that is not completely shown after they have dried to the slide. As a measurement for practical purposes, however, it is a duplication of the conditions which obtain in the covering of a leaf by means of Bordeaux mixture.

FIG. 3. Forms of precipitation membranes dried to slide. x about 250 times.

The shape and size of the membranes found on the slide were of considerable interest as they give a clue to some of the facts shown by the area measurements. In the Pickering Bordeaux the membranes are clear without granules of lime on their interior but in all the others the colloidal pellicle of the copper compound encloses on its interior, many minute particles of lime, apparently left undissolved from the treatment with the acetic acid potassium ferro-cyanide solution (Fig. 3). As seen dried to the slide there was the greatest irregularity of form and some of the shapes assumed are rather difficult of explanation. The most striking of these (Fig. 4) were the ones with a dense

FIG. 4. Form of precipitation membrane common in stronger mixtures. x about 250.

interior and radiating projections. A possible explanation is that the sack showed originally folds or other irregularities which in drying

changed to these narrow protruding arms. These large flecks were characteristic of the stronger Bordeaux mixtures such as 10-10-50 and the 20-20-50 while the membranes in the weaker mixtures were inclined to be smaller and thinner.

The results from 1 cc. of the six mixtures tried were as follows :

Pickering's Bordeaux mixture (saturated lime-water)	70.6 sq. cent.
2½-2½-50 Bordeaux mixture	111.8 " "
5-5-50 Bordeaux mixture	257.0 " "
10-10-50 Bordeaux mixture	393.6 " "
20-20-50 Bordeaux mixture	498.8 " "
Lime 5, copper sulphate to neutrality	296.6 " "

These results can best be shown graphically in the form of a curve, (Fig. 5). It will be seen at a glance that increasing the amount of copper sulphate and lime means an increase in the area of precipitation film produced. This increase is not constant, however, dropping off after the 5-5-50 concentration is reached, but up to that time the curve rises steadily. This dropping off is probably due to several causes : the membranes formed by the stronger solutions seem to be thicker and would use up more of the materials with less resulting area ; these thick membranes are more difficult to break and unless the two constituents are thoroughly stirred together, the precipitation vesicles remain large and do not present as much surface.

The amount of precipitation membrane as shown by this method is interesting in comparison with that measured in hydrometer jars in the ordinary way, after the precipitate has settled. Five lots of Bordeaux mixture were prepared, 500 cc. each, of the same formulæ as that used on the above work. These were placed in hydrometer jars and allowed to settle for 24 hours (Fig 6).

The following results are the average measurements in centimeters of the precipitates from five trials :

Pickering's Bordeaux mixture	7.8 centimetres.
2½-2½-50 Bordeaux mixture	3.8 "
5-5-50 Bordeaux mixture	5.4 "
10-10-50 Bordeaux mixture	11.9 "
20-20-50 Bordeaux mixture	13.0 "

The striking feature of these measurements is the apparently large amount of precipitate shown by Pickering's Bordeaux. That this large amount of membrane is only apparent, however, is shown by the actual measurements given above. The membranes formed between copper sulphate solution and lime water contain no lime to weigh them down causing them to sink. The same tendency is seen in the 2½-2½-50 mixture where there is always quite a layer of membranes

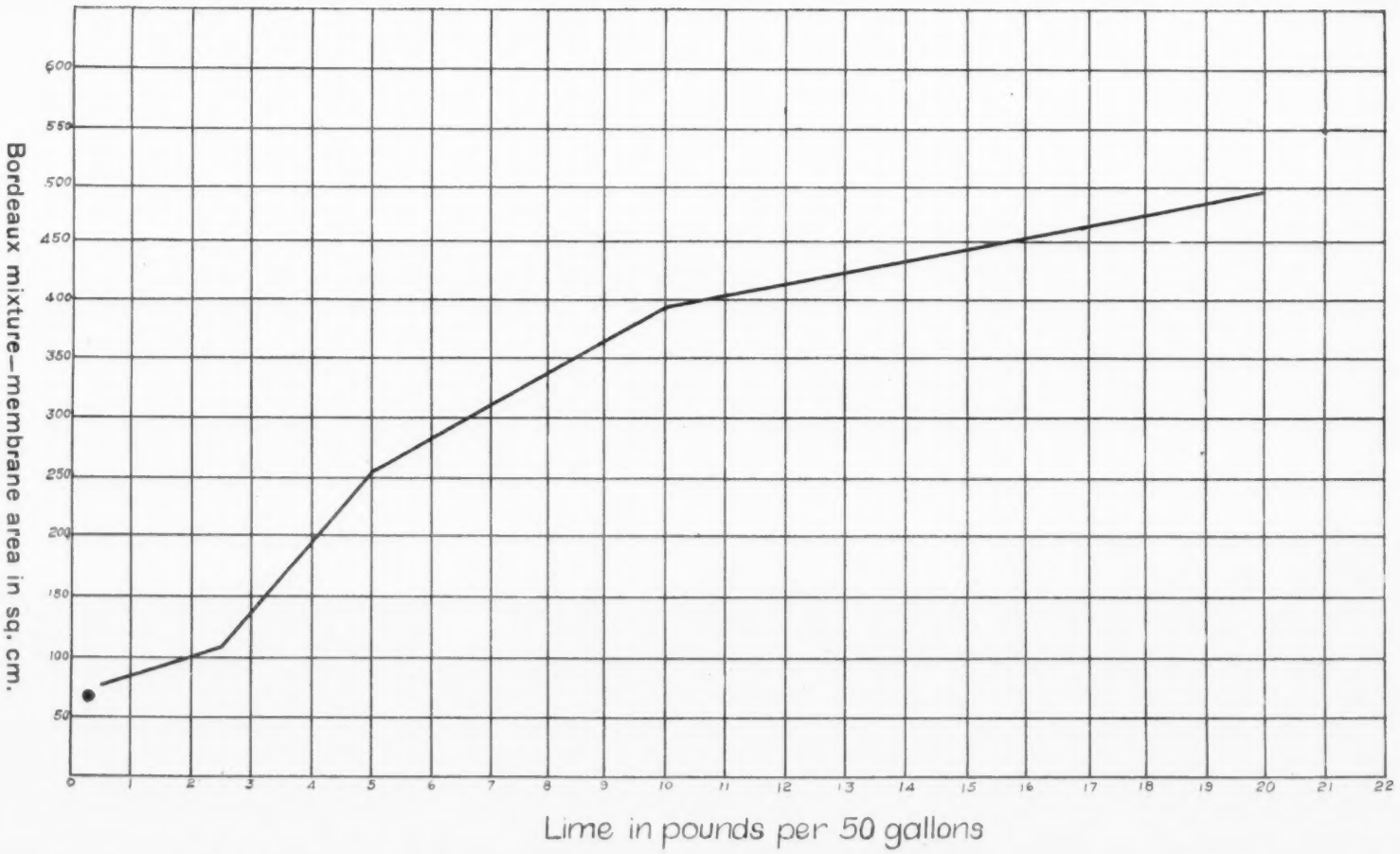

FIG. 5. Curve showing amount of Bordeaux mixture precipitation membrane obtained from varying amounts of lime; the copper sulphate being used in the same quantity by weight as the lime.

with little lime in them. These sink more slowly than those laden with lime and lie as a layer on top of the heavier particles.

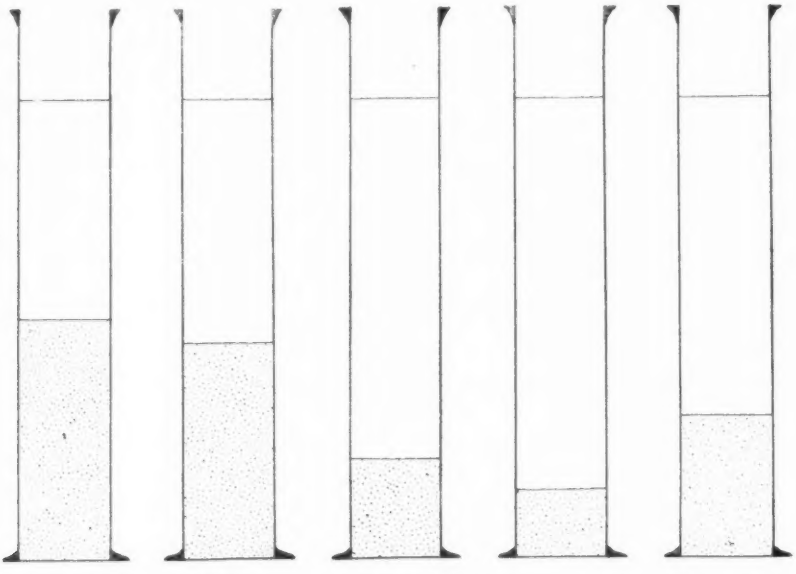

FIG. 6. Jars containing 500 cc. each, showing the amount of precipitate in I, 2½–2½–50, II, 5–5–50, III, 10–10–50, IV, 20–20–50, Bordeaux mixture and V, Pickering's Bordeaux mixture, after 24 hours.

According to the measurements as given by my method the 5–5–50 mixture should show a little more than twice the film of 2½–2½–50 mixture. The difference between the 10–10–50 and the 20–20–50 mixtures seems to correspond fairly well according to both methods.

Two important practical conclusions are to be deduced from this study of film area. The weaker solutions of lime and copper sulphate are to be preferred, as the membranes produced from them are easier to break by stirring and yield more covering area for the same quantity of materials. The other deduction is that if the covering power of the mixture made from the materials is to be obtained, thorough and vigorous stirring is necessary in order to break up as completely as possible every Bordeaux membrane.

Attention must be called to the fact that bulk for bulk the same quantity of Pickering's bordeaux does not have the same covering power as even the 2½–2½–50 mixture. On the other hand for the amount of material used it produces the greatest amount of film area. In all the other forms of Bordeaux mixture some of the lime is wasted and the films are probably thicker (thus using up more of the copper)

on account of the saturated lime water always within them. A marked superiority is also shown by this type of mixture in the slowness with which it settles out of suspension.

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Diseases of Plants (Phytopathology). A. A. Jaczewski, Volume I, General Discussion. Pp. 456, figs. 117, St. Petersburg, 1910. (In Russian).

The volume comprises an introduction of twenty-five pages, and five chapters, as follows: I. Influence of phytopathological factors, 103 pages; II. Susceptibility of plants to disease: inheritance, 59 pages; III. Geographical distribution and modes of dissemination, 34 pages; IV. General information about combatting and preventing plant diseases: fungicides and machinery, 223 pages; V. Practical information about collecting and preserving materials for phytopathological study, 11 pages.

The author's aim is to give preparation for original scientific investigation, and to furnish, in a popular way, knowledge of fundamental principles that will be of direct help in practice. This dual purpose has not always been happily carried out. Much space is given to the elementary discussion of such subjects as the characteristics of protoplasm, cell structure, plant tissues and organs, nutrition, etc., which would be an old story to any one who has studied any botany or general biology whatever. This is interspersed with illustrative references that cannot be understood by one who does not have a fairly extensive knowledge of mycology. With this unevenness of treatment, no very great heights are reached. Another general criticism is that the style is discursive, with much unnecessary repetition.

The subject matter is up-to-date, as a rule; and the citations of special literature, while less numerous than could be desired, are usually well selected. To an American plant pathologist the volume would be of most interest, perhaps, because it gives much information about plant diseases as they occur in eastern Europe, and from the viewpoint of one who has studied them at first hand for a long while.

The introduction sketches rapidly the history of phytopathology, discusses the classification of plant diseases, indicates statistically some losses caused by them particularly in Russia, and enumerates the important phytopathological books, periodicals and exsiccati, Russian contributions being enumerated in detail.

Chapter I considers the nature of disease and death, and the normal physiology and morphology of plants. In Chapter II the lists of Russian varieties susceptible or resistant to certain common diseases are unusually extensive. Chapter III is devoted much more to the second than to the first part of its title. Chapter IV gives a consider-

able amount of experimental data from which the usefulness of control measures has been deduced. The merits and demerits of a wide range of fungicidal preparations are discussed. The chapter ends with a very satisfactory account of experimental work along the lines of internal therapy of plants. The last chapter is too brief for any but the most elementary directions for handling materials.

It is proposed to follow this volume with a second one which will treat of morphology and physiology of fungi, fungous diseases, diseases due to algae (including bacteria), phenogamic parasites, diseases due to environmental and physiological factors. Diseases of Russian crops and useful wild plants will be emphasized, and complete indexes will be given.

H. R. FULTON.

WASHINGTON MEETING OF THE AMERICAN PHYTOPATHOLOGICAL SOCIETY

The third annual meeting of this Society was held in Washington, D. C., December 27-28, 1911, in affiliation with the American Association for the Advancement of Science.

There was a large attendance and a program of fifty-one papers was presented. The present membership is 249 of which five were elected at this meeting. Joint sessions with Section G of the American Association for the Advancement of Science, and also with the Botanical Society of America, were held.

The following officers were elected for 1912 :

President:—G. P. Clinton, Agricultural Experiment Station, New Haven, Conn.

Vice-President :—F. C. Stewart, New York Agricultural Experiment Station, Geneva, N. Y.

Secretary-Treasurer :—C. L. Shear, U. S. Dept. of Agriculture, Washington, D. C.

Councillors :—W. A. Orton, U. S. Dept. of Agriculture, Washington, D. C. 2 years.

Erwin F. Smith, U. S. Dept. of Agriculture, Washington, D. C.

A. D. Selby (ex officio) Ohio Agric. Experiment Station, Wooster, Ohio.

L. R. Jones (ex officio) University of Wisconsin, Madison, Wis.

At a meeting of the Council of the Society Dec. 29, it was decided that on account of the regulations of the Post Office Department regarding second-class matter, the Business Manager should discontinue sending the Journal to members more than three months in arrears.

The Business Manager of Phytopathology presented his report for the year which was accepted by the Council with thanks. It was also moved and carried that the Business Manager be paid fifty dollars ($50.00) for his services during the year 1911, also that one hundred dollars ($100.00) be appropriated from any funds in the treasury of the Society for the Business Manager for 1912.

It was decided to make no change in the subscription price to the Journal for the coming year, but to increase the size to 48 pages and to continue the present editorial staff.

The members elected since the last meeting were confirmed by the Council.

At a business meeting of the Society held Friday morning, Dec. 29, the action of the Council, as reported above, was confirmed.

The report of the Secretary-Treasurer was also read and accepted. It showed a cash balance of $218.44 in the treasury which is on deposit in the Citizens Savings Bank of Washington. The Treasurer's report was referred to an auditing committee consisting of G. P. Clinton, H. T. Güssow and A. B. Stout. This committee examined the accounts, reported them correct, and the report was accepted by the Society.

The financial report of the Business Manager was read and referred to the same auditing committee which approved the report and it was adopted by the Society. It showed a cash balance of $95.42 or $45.42 after deducting the $50.00 due the Business Manager. There are also outstanding bills to be collected amounting to $103.20, besides nearly 300 sets of volume I of the Journal.

The report of the committee on Plant Disease Names was called for but was postponed by request.

The report of the committee on Legislation concerning plant diseases was called for and in the absence of the chairman, Mel T. Cook, it was presented by F. C. Stewart. The report was accepted by the Society and the committee continued.

At the request of the Botanical Society of America a committee, consisting of the President and the Secretary-Treasurer, was appointed to consider the question of a closer affiliation with that Society.

The Phytopathological Exhibition was very interesting and instructive and attracted many visitors. This was a new feature of the annual meetings and was regarded as a great success.

It was proposed that at the next meeting there be a symposium of thirty minutes on "Preservation and Filing of Pathological Material" with exhibits of the same.

The regular program was opened with a short symposium on Pathological exhibits Ten-minute talks were given by F. C. Stewart, G. P. Clinton, H. H. Whetzel and A. D. Selby. Abstracts of two of these follow after which titles and abstracts of the other papers read are given.

Botanical Exhibits by the Connecticut Agricultural Experiment Station. G. P. CLINTON

This paper dealt with the phytopathological exhibits of the Botanical Department made at various Connecticut fairs during the past three years. Briefly stated, these exhibits the past year have shown (1) The more prominent plant diseases of the state by means of 168 Riker mounts of dried specimens; 30 to 40 jars of preserved specimens; 20 to 30 plates of fresh specimens. (2) Illustrations of fungi and their injury by means of photographs, half tones, charts, etc. (3) Artificial cultures of various parasitic fungi, and the methods employed in obtaining them. (4) Production of disease by means of artificial inoculation. (5) Various fungicides and their ingredients. (6) Results of studies and preventive treatments of special diseases, such as fungi of apples and peaches, potato blight, black knot, chestnut blight, etc.

To illustrate types of labels and manner of labeling and displaying these exhibits, a sample exhibit was made in connection with this paper.

Plant Disease Exhibits in Ohio. A. D. SELBY

The trays of diseased plants and photographs shown in the general exhibit of the Society, from the Ohio Station, arose from our experience in the first place, in preparing weed exhibits. In 1908 the Department of Botany of the Ohio Station

was called upon to offer material for traveling county fair exhibits. In 1911 these exhibits had developed into triplicate sets.

In the first place the writer designed frames of two sections, separated by an upright partition in the middle ; each section was designed to contain three sheets of standard herbarium size on which the specimens exhibited were mounted. This made six specimens on each tray, the exterior dimensions of the tray being 73½ x 19½ inches. The frames were made of yellow poplar and stained, so as to show as little damage from handling as might be.

When it seemed desirable to exhibit, as it did perhaps the same year, specimens of diseased plants, these were mounted in similar manner, and the trays were shipped about in the same container with the weed specimens.

The impairment of specimens by dust and the wreckage from handling led to a call for a transparent cover over the specimens. For this purpose celluloid of proper thickness was finally secured and has been since employed. To carry the protective covering of celluloid a narrow moulding around each of the two sections of the trays was found necessary, and also two uprights marking off by the equivalent of a frame each separate specimen with its label. This has proved very satisfactory for the years 1910-11, and is likely to be continued.

In the matter of labels we have chiefly given a common name of the disease or plant in capital letters, with the scientific name in smaller type. Beyond this, as a rule, it has not been the effort to convey information, since the attendants with the exhibits were prepared to answer questions of interested parties.

In addition to these exhibits of specimens and photographs in trays, at the annual state fair held at Columbus, Ohio, photographic enlargements were freely used, and museum specimens of diseased material preserved in jars were likewise added.

We find, as a matter of fact, that the portable trays with their elastic covering of celluloid, have proved best adapted to the handling, rehandling etc. at the county fair exhibits. At these the Experiment Station has a tent and the exhibits of all the Departments of the Station are collected together in this tent. The trays are supported on a sloping rack support, and on a protective rail in front other features may be exhibited, such as seed magnifiers after the manner designed by Brown, or any other feature adapted to use on a narrow rail.

Some Results of Lime-Sulphur Research in Oregon. A. B. CORDLEY

Read by title.

Cement Dust Injury to Fruit Trees. P. J. ANDERSON

At the request of fruit growers who claimed that the yield of their trees was decreased by dust from cement mills, an investigation of conditions was undertaken. The dust was found to contain a high per cent. of soluble calcium salt. Dissolving in the stigmatic secretions, it renders them alkaline and pollen will not germinate in this alkaline solution. Artificial tests of the pollen of cherries, pears and apples gave no germination even in very weak solutions of the dust. Farther tests show that there is no germination even when the calcium is not in the alkaline condition.

Relative Merits of Lime-Sulphur, Lead Benzoate and Bordeaux Mixture for Spraying Potatoes. F. C. STEWART and G. T. FRENCH

In 1911 the writers made a comparative test of lime-sulphur, lead benzoate and bordeaux mixture for spraying potatoes. The mixtures were applied thoroughly six times at intervals of two weeks. Tip-burn was the only important disease involved. Bordeaux checked the tip-burn, prolonged the life of the plants and in-

creased the yield at the rate of 100.3 bu. per acre ; lead benzoate neither benefited nor injured the plants; while plants sprayed with lime-sulphur were plainly smaller than the checks, quite as much affected by tip-burn and yielded 39.5 bu. per acre less than the checks. None of the mixtures burned the foliage.

The conclusion is that neither lime-sulphur nor lead benzoate can be profitably substituted for bordeax mixture in spraying potatoes. Both lack the stimulating influence possessed by bordeaux while lime-sulphur has, also, a tendency to dwarf the plants and lower the yield.

The Importance of Sanitation in the Control of Certain Plant Diseases. L. R. JONES

The use of fungicidal sprays is and must continue to be the chief reliance in combating many plant diseases. The emphasis upon their value, especially by horticulturists, has, however, led the public to consider them the main reliance, whereas their value is strictly limited. It is always easy and temporarily satisfying to prescribe a specific remedy, but often more fundamental sanitary measures should be emphasized. Recent experience in Wisconsin has shown this to be especially true with the diseases of certain special crops now being introduced with intensive culture into new regions for truck and canning purposes. Examples of such diseases where exclusion or inhibition through sanitation are of primary importance include : (1) cabbage diseases, especially club root (Plasmodiophora) black leg (Phoma) and yellows (Fusarium), the last two being most serious ; (2) pea diseases, especially *Ascochyta pisi* and *Septoria pisi*, of which the last has proved most serious ; (3) Cucurbit diseases, especially the bacterial wilt ; (4) Nursery diseases, especially crown gall.

The Factors Governing Germination and Infection with Phytophthora infestans I. E. MELHUS

In experiments involving some three hundred tests, at temperatures, 8° to 14° C. 96% germinated, while at 21° and 25° C. only 20% germinated, showing that comparatively low temperatures favor germination with *Phytophthora infestans* as well as with Cystopus. The optimum temperature for oospore germination lies somewhere between 10° and 13° C., the minimum between 1° and 2° C., and the maximum between 21° and 24° C. Field observations showed zoospore germination to occur freely on the potato plant at temperatures 8° to 15° C ; no conidia were found germinating directly.

Inocculation, 56 different experiments, show that temperatures 10° to 13° C. produce higher percentage of infection than 21° to 25° C. The upper surface of the potato leaf is less easily infected than the lower.

Bordeaux mixture and various polysulphides were investigated as to effect on spore germination with *Phytophthora infestans* and *Plasmopora viticola*. Varying amounts of lime in bordeaux mixture does not affect toxicity. None of constituents of the polysulphides were found toxic at the proportions occuring in the polysulphide ; the most toxic agent, however, was the alkali constituent. Germination of Phytophthora and Plasmopara occurred with solution Sherwin-Williams polysulphide, one per cent total solids, approximately equalling dilution 1 : 43 ; no germination with solution twice this strength. Calcium, sodium, and potassium polysulphides behaved in practically same manner as this.

Observations on the Deterioration and Utilization of Fire-Killed Timber in the Northwest. JAS. R. WEIR

This paper deals with the important problems of the disposal of the vast amount of fire-killed timber in the forests of northwestern United States, causes and rate of decay, and problems of general pathological interest in burned areas.

The Covering Power of the Precipitation Membranes of Bordeaux Mixture. B. F. LUTMAN

Published in full in this issue.

Notes upon Cronartium ribicola. PERLEY SPAULDING

A new and rather rare field character of the white pine blister rust disease is a coarse yellow mottling of the bark of the affected stem and of the needles. Definite tests show that a single inspection cannot be expected to remove all the diseased trees from an affected lot—that is, apparently healthy trees left by the first inspection will later develop the disease visibly. The disease was first found in the States of Virginia and New Jersey in 1911. The teleuto stage of this fungus has been found upon the stipule and bracts of *Ribes* leaves, indicating its possible occurrence upon the bud scales. This would account for the anomalous appearance of this disease on *Ribes* in some cases. Inoculations made a year ago upon young *Pinus strobus* are beginning to produce visible swellings.

Notes on Some Western Uredineae which Attack Forest Trees. GEORGE GRANT HEDGCOCK

A brief description was given of a number of species of *Peridermium* attacking conifers especially in the Western United States, with suggestions as to the species of rust that are probably the alternate generation of each of the following species: *Peridermium filamentosum* Peck., P. *pseudo-balsameum* (D. & A.) Arth. & Kern, P. *harknessii* Moore, and P. *montanum* Arth. & Kern.

Some Limiting Factors in the Control of Sugar Beet Diseases. C. O. TOWNSEND

Read by title.

Experiments in the Use of Asphaltum and Other Substances as Dressings for Wounds of Trees. JOHN BODDY

No abstract.

Cardinal Temperatures for the Germination of Uredospores of Cereal Rusts. EDWARD C. JOHNSON

The conditions governing the germination of the uredospores of rusts have been investigated from time to time, but a review of the literature shows that there has been little or no systematic effort made to determine the cardinal temperatures for the germination of uredospores of the rusts of *cereals*. Believing that such study would throw further light on the relation of meteorological conditions to rust development, investigations of the uredospores of *Puccinia graminis* on wheat, barley and oats, *P. rubigo-vera* on wheat and rye. and *P. coronata* on oats were commenced in 1910.

The spores were obtained from fresh material kept growing in the greenhouses at Washington, D. C. All germinations were made in distilled water hanging drops in the so-called Van-Tieghem cell. A series of dark incubators ranging in temperature from 1.5 to 31° C. were used. With the exception of *P. coronata*, with which only two tests were made, at least five tests of each species were made at each temperature.

In these experiments the minimum and maximum temperatures were found to be as follows: For *Puccinia graminis* on wheat, barley, and oats practically the same limits, or 2° C. and 31° C., the ultra minimum and ultra maximum being 1.5° and 32° C.; for *P. rubigo-vera* on wheat, the same limits and for *P. rubigo-vera* on rye, the same lower limit and a slightly lower upper limit, or about 30° C.; and for *P. coronata* on oats, by results thus far obtained, a considerably higher minimum, or 7 to 8° C. and a maximum of 30° C.

The optimum temperature can not be determined by percentages of germination, there being no uniformity of variation in this respect between 9 and 25° C. Taking the general vigor of the germination tube as the determining factor, the optimum temperature appears to be the same for the six forms studied and lies between 12 and 17° C.

These remarkably low cardinal temperatures help to explain such points as the difficulty with which infection takes place in excessively warm greenhouses and on hot summer days; the difficulty of finding viable uredospores in early spring, the majority already having germinated; and the favoring of rust development and epidemics by subnormal temperatures at the critical infection periods of the host plants.

Preliminary Notes on Three Rots of Juniper. GEORGE G. HEDGCOCK and WILLIAM H. LONG

Descriptions are given of the gross and microchemical characters of three heart rots of living junipers; also the distribution and damage done by each and technical descriptions of the sporophores are given. The rots discussed are white rot of juniper caused by *Fomes juniperinus* (Schrenk) Sacc. & Syd. Sacc. Syll. XVI.:151; yellow rot of juniper caused by *F. earlei* (Murrill) Sacc. & D. Sacc.; Sacc. Syll. XVII., 119; and stringy brown rot of juniper caused by *Fomes texanus* (Murrill) Hedgcock & Long.

The white rot attacks *Juniperus virginiana* and seems to be limited to the eastern portion of the United States. It produces holes with white borders of delignified wood.

The yellow rot attacks *Juniperus monosperma, J. utahensis,* and *J. sabinoides,* producing long tube-like holes in the heart wood. It is very common in New Mexico and is also found in western Texas, Arizona, and Colorado.

The stringy brown rot affects the heart wood of *Juniperus sabinoides, J. monosperma,* and *J. utahensis,* and is found in Western Texas, New Mexico, and Arizona. It is characterized by layers of rotted tissues (spring wood) alternating with more or less sound wood (summer wood) and usually does not produce holes in the heart wood.

Correlation between Certain Species of Puccinia and Uromyces. CLAYTON ROBERTS ORTON

The remarkable probability of a close specific relationship of certain rusts belonging to Puccinia and Uromyces, as for example *Puccinia subnitens* Dietel and *Uromyces Peckianus* Farlow, has been pointed out by Dr. J. C. Arthur, in a paper on culture work with Uredineae.

Recent taxonomic work preliminary to publication in the North American Flora, has brought to light several of these parallel forms, and with the aid and invaluable suggestions of Dr. Arthur and Dr. F. D. Kern, the writer has attempted to extend these ideas to a comparison of the American species in the long-cycle forms (eu-forms) in Puccinia and Uromyces inhabiting the same or closely related hosts of the same stages. In this paper it is desired to point out several instances of this probable relationship among both heteroecious and autoecious forms. This correlation may be of practical importance as an aid in solving the life histories of unconnected heteroecious rusts.

(*To be concluded*)

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